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TRAVELS
IN THE
TWO SICILIES,
AND
SOME PARTS OF THE APENNINES.

Translated from the Original Italian of the

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Padua, &c. &c.

IN FOUR VOLUMES.—WITH ELEVEN PLATES.

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1798.

TRAVELS

IN THE

TWO SICILIES

SOME EARLY OF THE REIGN

OF THE KING OF SICILY

BY
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TRAVELS

IN THE

TWO SICILIES, &c.

CHAP. XXIII.

CONSIDERATIONS RELATIVE TO THE ACTIVITY OF VOLCANIC FIRES.

Two contrary opinions concerning this activity; many naturalists imagining that it must be very great, and others that it is extremely weak—The arguments favourable to the former opinion examined—First argument deduced from the effects produced by the fire of a lava in motion, compared

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with those of common fire—Heat of this lava when it is disgorged from the subterranean caverns greater than that of our furnaces—Second argument, derived from the promptness with which cold lava is liquefied when thrown upon melted boiling lava, which cannot be obtained by common fire unless it be extremely powerful—The retention of a strong heat by lavas long after they have ceased to flow adduced as the third argument in favour of the great activity of volcanic fires—Fourth argument derived from the fusion of large masses of stones, and considerable tracts of country by rivers of lava flowing over them—Fifth argument deduced from the great difficulty with which the fusion of the volcanic glass of Iceland is obtained in common fire—The boiling of the waters of the sea in consequence of volcanic conflagrations a sixth argument of the great efficacy of the latter—The seventh and last argument derived from the great fluidity of lavas in many circumstances—The arguments, on the contrary, employed to prove that

that the activity of the fires of volcanos is extremely feeble, may be, in fact, reduced to one only; that is, that those fires produce no essential change in stones which have passed into lava, and are incapable of fusing shoerls; whereas the fire of our furnaces destroys by vitrification the primordial characters of these stones, with, commonly, a fusion of the shoerls—This argument more specious than solid; since it may be proved that it is not always true that volcanic fires are insufficient for the fusion of shoerls; as they sometimes melt the garnets of Vesuvius, which are refractory in our furnaces; and that the little or no alteration of the primordial characters in lavas is not to be ascribed to the feebleness of these fires, but to their manner of acting, which is different from that of common fire—The fire of the furnace sufficient to fuse rocks, whether volcanic or not volcanic; but incapable of producing in them true fluidity—A fire of much stronger temperature necessary for this—Enquiry how far the opinion of some can be maintained,

that the fire of volcanos produces its effects rather by the duration of its action than by its activity—The fire of our furnaces, remaining constantly the same for a few days, is incapable of fusing stones ; yet in a greater number of days will produce fusion in them ; but at the same time it destroys their texture, in the same manner as it would be destroyed by a fire of greater activity. Enquiry whether sulphur acts as a flux on the stones which pass into lava, or facilitates their fluidity ; and the negative concluded from a long series of facts—Proof, likewise, from numerous and certain observations, that there is little or no foundation for the opinion that flowing lavas, besides the caloric (heat) which they receive from the volcanos, contain likewise a caloric of their own, which, after the manner of inflammable bodies, is developed by a true combustion—Necessity of acknowledging that we have not clear and distinct ideas of volcanic fires—Our uncertainty relative to the nature of their aliment, and the manner in which they

they act independent of the concurrence of atmospheric air—Oxygenous gas, probably, the cause and preservative of subterranean conflagrations, and capable of producing singular combinations in the stony bodies it invests, when mixed with other gases and saline substances—Possibly water united to fire may contribute to produce such combinations.

THE terrible and stupendous scenes of globes of flame and fiery stones forced to a prodigious height, of mountains melted by violent heat, and rivers of burning lava, which in every age have presented themselves to the astonished eyes of men, have induced an almost general belief that the power of these destructive fires is much greater than any of which our common fire can furnish us an idea. This opinion, which always has been, and continues to be, that of the common people, and which has been embraced by many celebrated naturalists, would certainly at present be the

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prevailing

prevailing, or rather the only one, were it not that within these few years another, directly opposite to it, since it supposes the activity of volcanic conflagrations to be extremely feeble, has been advanced and defended by some professors of natural science. Both parties are, in fact, so fully persuaded of the truth of their respective opinions, that, while producing the arguments which appear favourable to their hypotheses, they appear to think it unnecessary even to listen to the objections and reasons of their antagonists. I shall consider it, however, as my duty, in examining this difficult and interesting controversy, my sole object being truth, to state fully and impartially the arguments on each side of the question. I shall therefore first give those which are or may be adduced to prove the powerful activity of volcanic fires; and next those in support of the contrary doctrine: accompanying each with such reflections as appear to me to arise out of the subject.

Argument I. As the intensity of common
fire

fire is measured by the effects it produces in the bodies on which it acts, it is evident that we must employ the same rule to measure that of volcanic fires. And, as we have seen that the pyrometer of Wedgewood is the most certain measure of these effects in common fire, it is indubitable that this instrument would afford the best means of ascertaining the activity of the heat of volcanos; and in Chap. I. of this work I pointed out a method by which it might be easily employed for this purpose in certain circumstances of the flowing lava.

Attempts have, however, been made by other, though less certain methods, to ascertain the degree of heat in lavas. I find such an experiment to have been made by some academicians of Naples in the famous eruption of Vesuvius in the year 1737, on a lava near the Torre del Greco, which, though it had ceased to flow for some days, still retained, in a bottom in which it had collected, a redness similar to that of red-hot

iron *. The following was the result of the experiments then made on the strength of the fire of this lava.

A piece of lead, of a conical form, two ounces in weight, being placed on the red-hot surface, after two minutes and a half became soft, and after three and a half was entirely melted. Another piece of lead, of the same figure and weight, was then placed on a red-hot plate of iron, laid over burning coals, when the metal did not begin to liquefy till after six minutes and a half, and was not entirely melted till seven minutes and a half.

Water placed on that lava, in a copper vessel, began to simmer at the end of three minutes, and, in the fourth, boiled furiously. When a similar experiment was made with an equal quantity, in the same vessel, placed over burning coals, it began to simmer

* Vide Srao, ubi sup.

strongly

strongly in four minutes, and in the fifth boiled violently.

From these experiments Professor Serao infers that the power of the fire of that lava, though deprived of a part of the heat it had when soft and flowing, much exceeded that of burning coals or red-hot iron.

I cannot but commend these experiments, principally because they are among the very few that have hitherto been made to ascertain a comparison between our common fire and that of volcanos. But though I can suppose that the heat of the lava exceeded that of red-hot coals, I cannot admit that it was greater than that of red-hot iron. The plate of which the Academicians made use, being surrounded on every side by the cold air, could not have that heat it would have retained in other circumstances. The glass furnace is inadequate to melt iron in the mass; but it will render it of a most violent red heat. But a cone of lead of the weight of two ounces, being placed on a
plate

plate of iron that had continued half an hour in this fire, was completely melted in less than one minute.

As this lava, however, had not flowed for some time, it must have lost no small quantity of its heat : hence, to obtain a more precise and adequate comparison, it was necessary to make experiments on it in the state of liquidity. This, partly by accident and partly by human industry, has been done. Among the prodigious destruction caused by a deluge of liquid matters, that which it occasioned in the convent of the Carmelites was not the least. The above-cited Neapolitan physician informs us that the fiery torrent entering that edifice, besides reducing to ashes the combustible matters, that were even at some distance from it, melted the drinking-glasses on the table of the refectory, reducing them to one shapeless mass.

We find a confirmation of this accident in the English Philosophical Transactions, in a paper given in by Prince Cassano, a mem-

ber

ber of the Royal Society, in which he relates that the torrent, after having fired the door of the church of the Carmelites, the windows of the sacristy and refectory, melted the glass vessels that were upon the table. He here adds an experiment of importance, which is, that *a piece of glass fixed to the end of a pole, and approached to the fluid matter, was reduced to a paste at the end of four minutes.*

This fact is corroborated by the following related by Professor Bottis, in his description of the conflagration of Vesuvius in 1667. His words are these: "In the middle of the same lava edifices were seen, some of which the lava had surrounded without injuring them; others it had broken and shattered, burning every thing before it. In some of them the flames from the torrent of fire had melted some large glass vessels which stood above, where the stream could not reach them."

On considering these facts, we cannot
2 admit

admit that the first of them, that is, the liquefaction of the drinking-glasses enveloped in the flowing lava, can be a convincing proof of its great activity, since we know that factitious glasses will melt more or less in our common fires. On the latter two of these facts, though to me they appear of less importance, I shall make some remarks. I imitated in some manner the experiment of the Prince di Cassano, relative to the fusion of glass approached to burning lava, by holding, in a pair of pincers, a piece of glass an inch in thickness, suspended in the air of a glass-furnace. In a few instants it began to soften, and, in a minute, to flow, forming a long descending thread. The efficacy, therefore, of this fire exceeded that of the fire of the lava in question, at least in the circumstances of this experiment. But here several particulars are to be remarked. According to the account in the Philosophical Transactions, the glass was approached to the flowing matter: it therefore did not touch it. It cannot be doubted but that, had it touched, it would more easily have fused.

fused. Besides, when this lava reached the convent of the Carmelites, it must have lost a considerable part of its heat, and that principally from two causes—First, because it had flowed over a long tract of ground, and, consequently, had communicated its heat, as well to the air immediately in contact with it, as to the ground over which it had passed : Secondly, because, when near the mouth whence it issued, it formed one single wide stream, which, as it proceeded, branched off into smaller channels ; and this division must greatly have diminished the activity of its heat. From these considerations it is evident that the heat of the lava, where the experiment was made, was greatly inferior to that it possessed when it was first disgorged from the mountain, which was probably much greater than that obtained in common glass-furnaces.

Argument II. The above-mentioned Professor Bottis, describing the eruption of Vesuvius, which began on the 29th of July 1779, and continued to the middle of August

gust following, relates that, on the 10th of September in the same year, making a visit to the mountain, " he observed a small hill, " formed of spongy stones, and surrounded " by lava recently ejected ; in which hill, he " adds, was a small gulph, of a figure almost " circular, about three palms in diameter and " two in depth. From this gulph proceeded " a low noise, similar to that of oil or any " fat substance simmering over the fire, " which sound was, no doubt, produced by " substances fusing in it. Its fire was so " strong that, some spongy stones being cast " into it, they immediately became red-hot, " and melted, producing the appearance of " boiling pitch."

This observation is of considerable importance in the present enquiry. Whoever is acquainted with the works of M. Bottis relative to Etna, will immediately perceive that by *spongy stones*, he means porous lavas, and the *scoriæ* of that mountain. In my experiments, I found that these do not require a continuance of less than half an hour
to

to soften them. If, therefore, the gulph into which these stones were thrown liquefied them like boiling pitch, it is evident that its heat greatly exceeded that of the furnace. I found on using a reverberatory furnace, of a high temperature, that it required a heat equal to that requisite to melt iron, to obtain a speedy fusion of these Vesuvian products, and, in general, of those of other volcanos. It is likewise equally evident that this small gulph, communicating from above with the cold air, must there be less strong than in its internal part, since that narrow mouth was only a spiracle or vent-hole to that great mass of lava, which boiled and flamed in the deep recesses of the mountain.

Argument III. The preservation of a strong heat in lavas which for some time, and, frequently, for a great length of time, have ceased to flow, may be considered as another proof of the vehemence of their heat, when they were fluid. The above-mentioned Professor Bottis observes that the
lava

lava of the year 1737 crossed a public road, and that, a month afterwards, labourers being employed by the order of the King to remove it, they were obliged to desist from the attempt, because the internal mass softened the iron instruments they used to break it. When not far from the highest crater of Etna, I crossed a lava which had flowed eleven months before, and was entirely detached from the volcanic furnace; I found it, notwithstanding, in some apertures, retain a red colour, which was very conspicuous to the eye in full day-light; and a staff being put upon it immediately smoked and took fire *.

Sir William Hamilton let fall some pieces of wood into the fissures of a lava, and they immediately took fire, though that lava had no communication with the volcano, and was full four miles distant from the mouth whence it had issued.

The lava of the great eruption of Etna

* See Chap. VIII.

in

in 1669, after eight years, had not become cold, in many places, according to the observations of Massa, a Sicilian writer,

These facts, compared and combined, furnish, in my opinion, another luminous proof of the powerful heat of volcanos. It is true that, eruptions usually occupying a great extent of ground, that extent causes them to preserve their heat longer; but it is equally true that, whatever may be the volume of the lavas, their heat would not be so great after such long intervals of time, were it not prodigiously more powerful at the time they flowed.

Argument IV. Fazello, the Sicilian, begins the description of an eruption of mount Etna, which happened in 1536, with these words: "IX calend. Aprilis, flante austro,
 "et sole ad occasum vergente, nubes atra
 "montis apicem operuit, et inter eam rubor
 "emicuit; tum repente, ex ipso cratere, ignei
 "torrentis vasta vis erupit; paullatimque in modum fluminis, magno montis
 VOL. IV. C "murmure

“murmure ac terræ motu defluens, in orientem versus descendit, lacumque illapsus
 “magnam ibi repertam lapidum congeriem
 “liquefecit.” On the 23d March, nearly about the time of sun-set, the south wind blowing, a black cloud, in the midst of which a kind of redness appeared, covered the top of the mountain; when, suddenly, a prodigious fiery torrent burst from the crater, and, flowing like a river down the eastern side of the mountain with a great noise and shaking of the earth, poured into a lake, where it melted a large quantity of stones that were amassed together.

This observation having been made at a time when accuracy and precision were not possessed by all observers, I must ingenuously confess that I should suspend my faith relative to the liquefaction of this great mass of stones, if I did not find it wonderfully confirmed in the description given by Mr. Pennant of a lava that issued from a volcano in Iceland, in 1783. After describing the prodigious extent of country that this lava covered,

covered, he remarks the perpendicular height of the sides of this current was from 80 to 100 feet; overwhelming not only all the villages that it found in its way, but likewise many hills: those that were too high to be thus submerged it melted; so that the entire surface of the country was in a state of fluidity, and formed a lake of fire, resembling a mass of melted metal.

I leave the reader to judge of the astonishing activity of this conflagration.

Argument V. Iceland also furnished another proof of the activity of its volcanos. We have seen that the glasses of the Eolian Isles, and those of the Phlegrean Fields, easily fuse in the furnace. As I did not possess any specimen of the Icelandic glass, I could not make any experiments upon it; but Bergmann, who had this advantage, observed, that he could not obtain a fusion of it with the blow-pipe: whence he concludes, that the fire which formed it must be extremely powerful.

Argument VI. Vallisneri, in his description of the new volcanic island which rose from the sea in the vicinity of Santorine in 1707, mentions, amongst other events which happened at that time, a circumstance of great importance to the present enquiry. At the time this island emerged from the waves, the sea round it was greatly agitated, and had acquired such an immoderate heat that it boiled, and the boiling extended to a considerable distance; by which a great quantity of fish was destroyed. We read the same fact in the travels of the Marquis de Choiseul, taken from a history of that time, in which it is likewise remarked that the pitch of some ships was melted.

This fact appears to me a sufficient proof of the violence of the fire of that volcano, since to heat to such a degree so enormous a mass of sea-waters, and that in a place so deep, presenting so large a surface, and surrounded, as they are, by cold waters, certainly required a very great development of the matter of heat.

A won-

A wonderful phenomenon of the same kind was also observed there in the ages of antiquity, according to Strabo *, who says that between Thera and Therasia the sea was seen to boil for four days. We have seen that Santorine consists of a prodigious mass of pumices, which stones have been thrown up from the bottom of the sea by the action of volcanic fire †. From the analysis I made of two pumices of that island, it appears that their base was the asbestus ‡. I know not whether the base of the other pumices of that place be of the same or of another stone; but in either case the two pumices that I analysed prove that the fire, by the action of which the asbestus passed into pumice, must be extremely powerful.

Argument VII and last. This is derived from the fluidity of the lavas. It is incon-

* Αναμεινον Θηρας και Θηρασιας, ενεπνευσαι φλογες εκ της πελαγους, εφ' ημερας τεσσαρας, ωστε πασαν ζειν και φλεισθαι την θαλασσαν.

† See Chap. XIX.

‡ See Chap. XV.

testable that a greater or less degree of heat must occasion a greater or less degree of fluidity. We shall speak presently of that degree of fluidity which lavas acquire in the furnace : we see that it is greater in a fire of high temperature, and it is still more increased when we employ oxygenous gas. These gradations of fluidity have, likewise, place in every other stone, as well as in a thousand other substances fusible in the fire. The reason is very evident, since the more the particles of a fusible body separate from each other by the interposition of a fiery fluid, the more complete is the fusion. If, therefore, we prove a great fluidity in the lavas, we shall also prove a proportionate violence in the fire. This we shall now make the object of our enquiry ; in which it will be impossible to be very brief, however we may wish for brevity, both from the variety of interesting facts to be adduced, and the remarks by which they must necessarily be accompanied.

To preserve some kind of order, we will divide these facts into two classes ; the first consisting

consisting of such as have relation to those lavas which are seen to spout up like water from volcanos, those which are found to retain softness after having been thrown through the air, and those which have been observed to boil within the craters.—In the second class we shall place such facts as relate to those kinds of lavas which, issuing from craters, or the sides of volcanos, and extending in long currents, have permitted observers to measure their velocity, and the degree of fluidity or softness they have acquired,

With respect to the former, two observations of Professor Bottis are worthy attention—the first relative to a circumstance observable in the eruption of Vesuvius in 1771, and the second respecting another that took place in the eruption of the same volcano in 1776. After having related that, by the side of the aperture whence the torrent of lava issued, four low hills suddenly rose at once, he remarks, that from three of these, which were in the form of cones, the fire

(that is to say, the ignited lava) spouted out from some small openings near their tops, precisely in the same manner as water when it is forced out through narrow channels or apertures. The curves which the inflamed fluid, issuing from these hills, described in falling, were of various dimensions. They all three threw up fire at the same time, and were, in fact, three beautiful and real fountains of fire.

From this fact Professor Bottis infers, that the fire of Vesuvius is very powerful ; and immediately adds, “ I have twice seen at a small distance from it the inflamed matter break forth and disgorge in the *Atrio del Cavallo*. From its great fluidity it resembled water issuing with violence from under the earth, and inundating the circumjacent country.

The substance of his other observation is, that Vesuvius, in the beginning of the year 1776, having poured from its summit a torrent of lava, it struck upon the lava of

1771,

1771, and rebounded into the air, congealing in small branches of various figures, terminating in thin sharp points like needles; as he observed the day after, when he ascended the mountain. Hence he remarks, that *this matter must have been extremely fluid, as that usually is which is ejected from the mouth of Vesuvius.*

We will now say a word of that softness which, sometimes, though rarely, the pieces of lava retain after they have been thrown through the air from the mouths of volcanos, and fallen on the ground. An instance of this is related by the same M. Bottis, which is so extraordinary that I should doubt the fact, were not the relater a person highly worthy of credit; and had it not been witnessed by those illustrious and eminent personages, his Royal Highness Maximilian Archduke of Austria, his Eminence the Count de Wilzeck minister plenipotentiary, his Eminence Cardinal Herzan, and Sir William Hamilton, with several others of rank and learning.

When lavas are thrown up from volcanos in the form of a fiery hail, before they reach the earth they have commonly already acquired the hardness of stone, from the strong impression of the cold air ; which, acting on pieces of such small dimensions, in a few moments deprives them of all fluidity. I had a favourable opportunity for observing this when I was at the mouth of the volcano of Stromboli, and protected, as I have already described, from the fury of its ejections ; notwithstanding several globes of lava fell very near me. On examining some of those that had fallen, I found them indeed strongly ignited, and at the same time as hard as stones.

Very different was the fact which occurred at Vesuvius, when, at break of day on the 19th of June 1775, the above-mentioned illustrious spectators observed it near its summit. The volcano, then, ejected a quantity of liquefied stones. As one of these fell, one of the guides ran speedily to it, and, with the point of a staff, perforated it

It from side to side, and presented it, with the staff thus passed through it, to the Archduke; who so much admired this extraordinary phenomenon, that he ordered the perforated lava, which weighed about eight pounds, to be preserved, together with the staff, in his private cabinet. If, therefore, that fragment of lava, of so small a size, remained still soft, notwithstanding the continual contact of cold air, it is a strong argument that within the crater it was extremely fluid. It must, however, be acknowledged that, even at Vesuvius, such phenomena are extremely rare, and are probably produced by an action of the fire more powerful than ordinary; for, if melted stones, when thrown from volcanos, had the softness and pliability of paste at the time they struck the mountain, it is evident they must be beaten in by the blow, and take more or less of a flat shape; which is contrary to experience. At least, among those pieces of lava that Vesuvius ejected when I was there, and of which I collected several, I observed that they all inclined to the

the orbicular figure, without any sensible flattening* ; and, in making the tour of the mountain, I found innumerable others which had been thrown out before, of a similar shape. Beside those of Stromboli, I observed the same conformation in various stones of Etna thrown out in the eruption of 1787 †.

We will now proceed to adduce an instance of the great fluidity of the lavas burning within the craters. Of this we have two observations of no common kind, made by the above-cited Professor, an indefatigable enquirer into the nature of the eruptions and other symptoms of the volcano in his vicinity.

“ The same night the mountain exhibited
 “ an extraordinary spectacle : a hollow noise
 “ was heard from time to time, after which
 “ a great quantity of extremely fluid fiery
 “ matter overflowed the edges of the mouth,

* See Chap. I.

† See Chap. VIII.

“ which

“ which first inundated almost the whole
 “ neck of the mountain, and, then, divided
 “ into various serpentine rivulets of fire,
 “ which ran rapidly down its sides, and,
 “ after six minutes, or nearly so, became
 “ extinguished. This was repeated at in-
 “ tervals, during the space of three hours,
 “ the same night.” We find this in his
 account of the conflagration of Vesuvius in
 1767.

In his account of that in 1779, he uses
 the following comparison—“ As a liquor
 “ which boils in a vessel rises and overflows
 “ the edges of that vessel from the violence
 “ of the heat ; thus, frequently, from the
 “ grand mouth of the mountain, the great
 “ quantity of extremely fluid fiery matter
 “ issued, in almost every part, and pour-
 “ ed down its sides, destroying all before
 “ it.”

These two observations, which evidently
 demonstrate the extreme fluidity of the lava
 when

when boiling in the crater of Vesuvius, correspond exactly with what I myself observed in the two craters of Etna and Stromboli ; nor can I doubt but the same facts are observable in the effervescent matters of other volcanos.

According to the order which I have prescribed to myself, I shall now proceed to speak of those rivers of lava which pour forth from volcanos, and, frequently, dividing into several branches, rush down the sides of the mountain, continuing their motion to a great distance. As their velocity is often very considerable, it may be concluded that their fluidity, and consequently the activity of the fire, must be so likewise. The stream of lava that issued from Vesuvius, in the eruption in 1751, flowed over the space of twenty-eight palms in a minute.

In the eruption of the same volcano in 1754, the lava formed two branches which
flowed

flowed thirty feet in forty-five seconds, and, uniting lower down, proceeded at the rate of thirty-three feet in fifty seconds.

To these two observations, which are by Father Turre, I shall add two others from Sir William Hamilton. The first relates to the eruption of the same mountain which happened in 1765, in which he remarks that the progress of the lava was at the rate of about a mile an hour. His second observation respects another branch of the same eruption, of which he does not determine the precise velocity ; but it must have flowed with great rapidity, as he tells us he is sure that, for the first mile, the velocity of this torrent was equal to that of the river Severn, at the passage, near Bristol.

The Marchese Galiani, in his Observations on Vesuvius, writes that, in the year 1631, about ten at night, on the 17th of September, a lava was seen flowing from the upper mouth of the mountain, which in three hours after had already entered the
sea,

sea, within which it formed three very long promontories ; a proof, as he justly remarks, of the astonishing velocity of these lavas.

I cannot conclude without mentioning another observation, on the same subject, from M. Bottis. On the first issuing of the lava from Vesuvius, in the year 1767, its velocity was so great, that some persons who were near the place had scarcely time to make their escape.

In 1771, a dreadful torrent of lava rushed from the mountain ; which, when it reached the *Canale dell' Arena*, had traversed, within an hour, the space of fifteen hundred Neapolitan *canne* *.

In the eruption of 1776, Vesuvius threw out from its summit a torrent of lava which flowed a mile and a half in fourteen minutes. The Abbate Francisco Ferrara, of

* The Neapolitan *canna* consists of eight Neapolitan palms, and a Neapolitan palm is nearly one sixth shorter than a Paris foot.

Catania, who observed, on the spot, the eruption of mount Etna in 1792, informed me that the lava of that eruption advanced at the rate of a pace for every stroke of his pulse, which, he added, was very quick.

These examples are sufficient to show the great velocity of lavas. It is necessary, however, to remember that I have chosen these instances from among those in which its velocity was greatest. Many others might be adduced, in which it is moderate, and others in which it is extremely small. In general, however, this velocity may be increased or diminished from many causes. Where the declivity, down which the lavas descend, is great, they move more swiftly, and *vice versa*. Their course also will be more rapid, the nearer they are to the orifice whence they issued. In general, lavas, in any of the above-mentioned circumstances, either do not move at all, or move very slowly, if they are not pressed forward by new supplies of melted matter. Hence, very frequently, a torrent of lava that has

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but just issued from the volcano, will stop, even on a steep declivity, from a failure of new matter pressing upon it, and compelling it to proceed.

To return to my principal subject; it may be remarked that, were we deprived of the observations mentioned above, which show the great fluidity of lavas in certain circumstances, their exterior velocity might lead us into an error; since it is well known that the tenacity and consistence of lavas is very great, even when they flow with the greatest rapidity.

Sir William Hamilton, describing the Vesuvian lava of the year 1765, which flowed at the rate of a mile an hour, tells us its consistence was such, that it almost resisted any impression of a long pole; and that some large stones, thrown into it with great force, did not sink, but, making only a slight impression, swam upon its surface.

In my excursion to Vesuvius, I remarked a similar resistance in the lava which ran underground through a narrow channel, into which great stones being thrown with force, sank only to one third of their bulk, and then were carried away by the current. In another broader torrent of this lava that flowed in the open air, large stones, thrown in like manner, made no impression *.

Dr. Serao affirms that many persons have frequently struck the external parts of lava, when it was in actual motion, with long staves, and found it so hard that it resounded with the blow.

Bottis informs us that, in the Vesuvian conflagration of 1770, a learned friend of his, seeing a stream of that eruption flowing rapidly (he describes it as passing the space of forty palms in one minute), attempted to ascertain its fluidity. With that intent, he

* Some of these facts have already been stated in Chap. I; but it was necessary to repeat them here to compare them with others.

took a staff, and endeavoured to force it into the liquid burning matter ; but, contrary to his expectation, he found it resisting and tenacious, and perceived that the staff had scarcely entered it, though he had thrust it with all his force.

I am not, therefore, greatly surprised when I read that some persons have passed over the lava in motion, without receiving any injury. M. Jamineau, English consul at Naples, having gone, with some others, in 1754, to observe an eruption of Vesuvius, one of the guides, coming to a stream of lava which moved slowly, found no difficulty in running over it. Sir W. Hamilton had the courage to do the same, though in some measure compelled by necessity, in the great Vesuvian eruption in 1779. He was then near a stream of lava which flowed slowly, and was from between fifty to sixty feet in breadth, when he found himself so incommoded by the heat, and the smoke which the wind blew upon him, that he would have been obliged to return, without
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satisfying his curiosity, if the guide had not proposed to him to cross the lava itself as swiftly as possible. The proposal being accepted, the guide passed over without any great difficulty, and was followed by the English naturalist, and by another English gentleman who accompanied him, none of them experiencing any other inconvenience than excessive heat in the feet and legs.

The above-cited Marquis Galiani, and other persons of resolution, passed in the same manner over currents of lavas actually in motion.

This tenacity and resistance of lavas, even when flowing, is a consequence, as is evident, of the action of the cold atmosphere, which, coming in contact with the surface, deprives them of so much heat that they lose their former fluidity. This loss of heat is, however, incomparably greater on the surface than in the internal parts; where the lava still retains a considerable degree of fluidity, as appears on breaking the crust

that covers it. M. Jamineau, above cited, though he remarks that the external coat of the lava, observed by him, was so hard that the heaviest stones made no impression on it, found, at the same time, that the internal mass might be easily penetrated by a small stick. Father Torre, in like manner, in the eruption of Vesuvius in 1754, having broken the external crust of a branch of lava which no longer flowed, a fluid boiling matter issued from the orifice.

But there is no fact more memorable, or more apposite to the present subject, in the history of volcanos, than that related by Borelli in his account of the eruption of mount Etna in 1669. An impetuous river of lava, disgorged from Monte Rosso, having destroyed all the villages and fruitful fields it met in its way, was ready to rise above the walls of the illustrious city Catania. In these dreadful circumstances some of the inhabitants conceived a bold expedient to ward off from their houses this threatening torrent of fire. With hammers
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and other suitable instruments, they made an opening in the side of the lava, the surface of which was already hardened, so that the internal matter, which still continued fluid, might issue out and take its course in another direction.

This bold attempt was crowned by the most complete success; since, the external crust being broken laterally, the matter, which still remained fluid, poured out, and flowed to a considerable distance, on that side to which it was thus turned. It is difficult to say by what fatality the same expedient was not had recourse to in other cases of similar necessity.

Though the velocity, therefore, of the external parts of lavas may be considered as an inconclusive proof of their fluidity, this fluidity will be very evident when we observe the internal; and, in certain eruptions such as that last mentioned, it must be owned to be extreme. This Etnean lava flowed the distance of more than fourteen

miles, from the base of Monte Rosso to the sea. Scarcely had it issued from its source, when it lost all communication with the internal volcano: and though, from the crust which formed over it, it preserved more or less of its heat, that must necessarily diminish continually, in proportion as the lava descended, removed to a greater distance from its source, and, instead of one single trunk which it formed at first, was divided into several branches; and successively and uninterruptedly communicated a part of its heat to the internal sides of the channels in which it flowed.

If, therefore, notwithstanding this constant loss of heat, the lava remained liquid and flowing, for the space of fourteen miles, how great must have been its fluidity when it first issued from the Etnean furnace!

But this is not the greatest distance to which the lavas of mount Etna have flowed; as we know that others have run eighteen, twenty, and even, sometimes, thirty miles.

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In the eruption mentioned by Sir W. Hamilton, which I likewise observed, the lava, that issued from the highest crater flowed to the distance of fifteen miles, and plunged into the sea at Taormina.

Since the conflagrations of volcanos have been recorded in history, I know no eruption more remarkable, for the extent of ground occupied by it, than that of Iceland in the year 1783, mentioned above; which, from the account we have received of it, dried up twelve rivers, and extended ninety-four miles in length and fifty in breadth. It is impossible to conceive that lava can inundate so vast a tract of country, without supposing its fluidity, at least in its external parts, to have been very great. Whether, therefore, we consider the lavas issuing from fissures of volcanos like gushing waters, or preserving a great degree of softness though divided in fragments and surrounded by the cold air, or boiling and foaming within their craters, or precipitating like rivers down the declivities

declivities of the mountains, it is indubitable that, in all these circumstances, they must possess, at least when they first break forth from the volcanic mouths, a very great fluidity, which fluidity can only have been produced by a proportionate heat.

These are the arguments, in my opinion, the strongest and most convincing that can be produced in favour of the activity of volcanic conflagrations—We will now consider those which are alleged on the other side, to prove that this activity is very small. These may conveniently be reduced to one alone; which is founded on the consideration that no destruction of the original character, or essential change, takes place in stones or rocks, which have passed into the state of lava by the action of volcanic fires. The first naturalists who advanced this opinion were M. Sage, and T. A. Deluc, who, from observing some of our furnaces vitrify lavas much more perfectly than volcanos, and that they melt shoerls, which are found untouched

touched in the lavas, inferred that the fire of our furnaces was superior in activity to that of volcanos.

M. Dolomieu has endeavoured still more to diminish this activity, on which he has made some observations, in almost all his works. In his "Travels to the Lipari Islands," after having said that some lavas at Saline extremely resemble porphyry, having nearly the same colour, the same consistence, and the same felspar spots; he deduces as a consequence from it, that the volcanic fires, in liquefying stones, do not at all change their natural texture; and that the fusion of lavas is very different from that produced in our furnaces, in which all the substances we subject to the experiment lose their figure by vitrification. In a long note which he has added relative to the Etnean lava in 1669, and the shoerls and felspars which were found within it uninjured, he endeavours to prove, that the fire of volcanos acts only as a dissolvent; that it dilates bodies, and insinuates itself within
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the particles, so that they slide one over the other, and, when it is dissipated, leaves the different substances nearly as it found them. Hence he compares the action of volcanic fire with that of water in the solution of salts, which participate the fluidity of the dissolvent, and resume their concrete form by evaporation.

In his introduction to his "Descriptive Catalogue of the Products of Etna," he repeats the same observation, and remarks the incapability of volcanic fire to vitrify shoerls, though in themselves easily fusible, whence he concludes *that the fire of volcanos is not intense*. He shows likewise that it is incapable of altering the texture of stony bases ; even when it liquefies them.

That the reader may form a clear idea of the opinion of this ingenious French naturalist, I shall cite the following passage from a Memoir he has recently published on Basaltes : " I shall again repeat what cannot be too frequently inculcated, that
" lavas

" lavas are not vitrifications ; their fluidity
 " is fimilar to that of metals reduced to fu-
 " sion ; it does not change the order, and
 " manner of being, of the constituent parts
 " of the lavas. When they cease to flow,
 " they refume, like metals, the grain, tex-
 " ture, and all the characters of their primi-
 " tive bafe ; effects which we cannot pro-
 " duce upon ftones in our furnaces, fince
 " we know not how to foften them by fire
 " without changing the manner in which
 " they are aggregated. The fire of volcanos
 " has not that intensity which is fupposed,
 " and produces its effects rather by the ex-
 " tenfion and duration of its action, than by
 " its activity *."

We have here the argument on the con-
 trary fide placed in its full light. Among
 the various reafons which induced me to
 fubject volcanic productions to the furnace,
 one was, that I might obferve the changes
 produced in them by common fire : I con-

* Rofier, Journal de Phyfique, t. xxxvii. an. 1790.

stantly found that the characters of the primordial rocks were destroyed by vitrification, and the shoerls, if not always, very frequently fused. When treating of the Eugeanean lavas, which abound in micas and felspar, we have seen that both these stones frequently melt in the same fire. Lastly, it appears from many parts of this work, that only rocks and stones not volcanic fuse in the furnace, without losing their characteristic lineaments. The facts therefore adduced to prove the weakness of volcanic fires are unquestionable, and have a very seducing appearance. We will now state the argument on this side of the question in its whole force.—The fire of volcanos is less efficacious and powerful than our common fire, if it leaves untouched, or little altered, the structure of the rocks it fuses, when this structure is destroyed by the fusion occasioned by common fire.—The fire of volcanos is less efficacious and powerful than our common fires, if it is incapable of producing the fusion of the shoerls, felspars, and micas, which may be effected by
common

common fire. But both these propositions have been proved by the facts adduced—Therefore, &c.

I will candidly confess, that, having continually before my eyes lavas, including shoerls and felspars, retaining their primitive texture, and finding them to be so changed as to be no longer known after refusion in the furnace, my whole attention being then directed to these objects of comparison, I have more than once been inclined to believe that the fire of the furnace was more energetic than that of volcanos ; and this opinion I have not concealed in several parts of this work.

Having, however, afterwards carefully attended to what has been written both for and against this activity, the arguments in its favour appear to me to have much more force than those on the other side. I do not however deny but that there are cases in which the activity of volcanos may be but moderate and even small ; this depending,
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in fact, on the greater or less development of caloric (heat) collected in their fiery gulphs.

With respect to the little or no alteration which takes place in the primitive texture of the rocks changed into lava, and the insufficiency of the shoerls and felspars, I think they are both to be ascribed not to the feebleness of these fires, but to their manner of acting, which is probably different from that of common fire, and hitherto not sufficiently known to us. On examining the degree of heat necessary for the fusion of certain lavas, and that of the shoerls they contain, in common fire, I have observed that the bases of several melt with a less degree than is required for the fusion of their shoerls; but that the bases of others require a greater degree; so that, in some cases, that degree of heat which melts the shoerls, is insufficient to fuse the base of the lavas within which they are included: yet, in these latter, volcanic fires have produced a quite contrary effect, having fused the base
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of the lavas, and left the shoerls in them untouched.

In Chap. XVI. we have remarked the infusibility of the Vesuvian garnets in the furnace, and the great difficulty of fusing them in a heat of the highest temperature. Yet, in many lavas with a horn-stone base, these are found half vitrified by the fires of Vesuvius, with the entire vitrification of the shoerls, as has been shown by the Chevalier Gioeni, in his *Lithologia Vesuviana*. M. Joinville found some garnets in the lavas of Cività-Castellana, which were fused together with their shoerls *. In Chap. III. I have given a description of these garnets, which I collected on the spot, and have remarked that they resembled the Vesuvian. They are found partly with a lava of a horn-stone base. I collected a considerable number of them, and found that the assertion of M. Joinville was very true ; as among many that were untouched and crystallized, there

* Rosier, Journal de Physique, an. 1788.

were some that were vitrified, and amorphous. It was remarkable that the lava which contained them, though in some small degree vitrified, had not lost the characters of the horn-stone. The experiments I made showed that the garnets of Civit -Castellana were equally infusible in the furnace with those of Vesuvius, notwithstanding their base was completely vitrified in the same fire.

These facts prove, First, that it is not always true that volcanic fires are insufficient for the fusion of shoerls. Secondly, by the vitrification of the garnets, they confirm the powerful activity of those fires. Thirdly, that those fires operate in a manner in some measure unknown to us ; since, at the same time that they vitrify the garnets, they leave the base in which they are included in a state perfectly recognizable, notwithstanding that the former are refractory to the fire of the furnace, while the latter is easily fusible.

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It is also easy to show, by other means, that the comparison between the fire of our common furnaces and that of volcanos, which is adduced by the opposers of the activity of the latter fires as their strongest argument, is extremely fallacious ; since, taken in another point of view, they prove directly the contrary. In the observations and experiments I have made on lavas, we have already seen that they almost all fuse in the furnace, forming in the upper part of the crucible either a horizontal, a depressed, or a rising surface. It has, likewise, been remarked that many lavas, in refusion, flow over the edges of the crucible, and form streams down its sides. From observing the facility with which lavas fuse in the furnace, and the manner in which they overflow the crucible, I concluded that in this state they must be extremely fluid ; but what was my surprise when I found their complete liquefaction accompanied with an unexpected tenacity and consistence ! When they had remained in a state of

fusion for several hours in the crucibles, so that some of them actually boiled, when I attempted to immerge into them vertically a pointed iron wire, I could scarcely, with all my force, plunge it to the bottom; and, in some, it did not penetrate more than three or four lines. When I took away the iron, the impression it had made likewise remained, though the crucibles still continued in the furnace during the experiment, and was filled up by the liquid matter, till after nine or ten minutes. And, when I took the crucibles with a pair of iron tongs, and inverted them within the furnace, the melted lava did not flow out; though, in a quarter of an hour, or nearly so, a thread of lava would slowly descend from the inner edge, which could scarcely be detached with another pair of tongs.

These experiments, the results of which I considered as very extraordinary, I repeated on a larger scale, fusing the lavas in capacious clay receivers. I then endeavoured

voured to perforate them with sharp iron wires, and tried the effects of inversion, without finding any sensible difference.

Nor did I omit to make similar experiments on those lavas which it is known were extremely fluid when they first issued from the sides of the volcanic mountains; such as the lava of Etna, which flowed, in 1669, to the distance of fourteen miles; that which precipitated into the sea near Taormina, after having flowed thirty miles; and several others of the same immense mountain, which had formed very long currents.

While employed in these curious experiments, from which I found such unexpected results, I resolved to try whether, by continuing the lavas a long time in the furnace, they might not lose their great tenacity and consistence, and become, at length, extremely fluid, and such as they were when they were disgorged from the volcanic mouths. I therefore continued several lavas, and some of those volcanic glasses which

become extremely full of bubbles, in the furnace, for forty days. The consequence was, that the mass of every lava and volcanic glass was greatly diminished in the crucible by evaporation; the bubbles in the glasses, as also in some of the lavas, were in a great degree destroyed, though some had acquired a greater number of those bubbles. The vitrification, therefore, of these bodies had become more perfect and more pure; but so far were they from having acquired greater fluidity, that the pointed iron wire scarcely made any impression upon them.

I afterwards proceeded to make experiments on these lavas in a much more powerful fire than that of the glass furnace; I mean a chemical reverberatory furnace. In this, the lavas became much more soft. They were reduced to the state of a soft paste. The pointed iron penetrated them, and the cavity it made was presently filled. On inverting the crucibles, the lava flowed out of them in the same manner as pitch would have

have flowed, when not entirely melted by the fire.

I afterwards employed oxygenous gas, putting small pieces of several lavas on burning coals, excited by that efficacious agent. The lava then became red-hot almost in an instant, took the form of a globule, and, on inclining the coal on which the globule rested, flowed like water.

On subjecting certain stones not volcanic to the action of these three different kinds of fires; I found in them the same resistance in the common furnace, the same softness in the reverberatory furnace, and the same fluidity when oxygenous gas was employed.

The learned reader must immediately perceive the consequence to be deduced from these experiments. If the fire of the glass-furnace, though it fuses lavas and rocks not volcanic, does not render them truly fluid, to effect which a considerably more

powerful heat is necessary ; and if this fluidity (which I do not say is to be compared to that of water, but which it is necessary they should possess when they flow) is produced in these rocks by volcanic fire ; it surely cannot be doubted that this fire is far more powerful than that of the glass-furnace.

But here it is necessary to recollect that the heat of the furnace, besides vitrifying the lavas, fuses the shoerls and felspars which remain untouched in that of volcanos, though we have proved that the latter is more active : an argument which, in my opinion, conclusively demonstrates that the infusibility of these stones is improperly ascribed to the want of activity in the subterranean conflagrations.

Though, from the numerous facts adduced, it appears to me evident that the fluidity of a lava flowing down the sides of volcanic mountains is the effect of an igneous fluid with which it is copiously penetrated,

trated, I shall not omit to consider two arguments produced by M. Dolomieu, to prove that lavas may flow, without the action of a violent heat. His opinion is, first, that *the fire of volcanos* (as has been before mentioned) *produces its effects rather by the duration of its action, than by its activity.* It is, he supposes, very feeble, and therefore incapable of changing the rocks, or fusing the shoerlaceous and feltspathose crySTALLIZATIONS; but by being a long time applied to them, it separates their particles, and causes them to flow. In the second place, the ignited sulphur, of which volcanos are never destitute, must, according to him, greatly promote this fusion.

To ascertain the force of these arguments I made several experiments. As the French Naturalist has supposed that the volcanic fire, though feeble, may by long continued action render fluid the stony substances it invests, without altering their original structure, I wished to try the result of leaving some stones for a long time in such a degree
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of heat, as was insufficient to fuse them in a time moderately short. The glass furnaces of Pavia were very convenient for such an experiment, since the degree of heat in them is, to every appearance, the same, during the whole time that the melted glass remains in them; that is, five-and-forty days; and is only made somewhat more intense during the fifteen following days, in which they melt and work the crystal glass.

This equality of heat is proved first by the practical observation of the workmen. The melted glass in the *padelle*, or large clay vessels in which it is contained, is susceptible of greater or less liquidity, according as the fire which acts on it is more or less intense. If its liquidity be too great, it is unfit to be worked, because it will not adhere to the iron tubes employed to blow it; and if it be not sufficiently liquefied, it is equally unfit, because it cannot be blown. A moderate degree of liquidity is therefore necessary, which the workmen are able to obtain,
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by a determinate degree of fire, which they continue always the same. Besides that they know this mean liquidity by the touch, they can likewise discern it by the sight alone; the glass then having a clear light red colour, which becomes an extremely lively white, scarcely supportable to the eye, when the fluidity is too great; and, on the contrary, a dark dull red, when it is too little.

I was not, however, satisfied with this rule, to ascertain the equality of the heat; but to obtain a more precise and determinate proof it, I had recourse to the pyrometer of Wedgewood. I placed four clay cylinders in their case, in that part of the furnace where I made my experiments on the stones: two of them I took out after two days, and let the other two remain, during the whole time the melted glass remained, that is, five-and-forty days; when on measuring, and comparing the contraction of the two former with that of the two latter, I could not discover the least difference.

difference. I was therefore physically certain, that the heat had continued the same during the whole of that interval of time.

The stones employed in these experiments were of those kinds which had been found refractory in the furnace, after a continuance of two or three days; that is, some felspars in the mass, and some petrosilices; though other congenerous stones, in the same circumstances of time and place, had been fused. I added to them the six pitch-stones, mentioned in Chap. XX. which were not in the least liquefied, after continuing eight-and-forty hours in the furnace; as also the filex, or red flint, of the Cava della Battaglia in the Euganean mountains, mentioned in the same chapter. These stones, eighteen in number, were thus left in the furnace, in a heat constantly equal. I carefully observed them from day to day, to notice what changes might take place in them; but to give a prolix journal of the remarks I made, would probably only tire my readers. It appears sufficient, for my present

present purpose, to state the final result, with a few remarks on some particular circumstances. I shall say, therefore, that there were none of them which were not more or less vitrified; in some, the vitrification had commenced after the eleventh day, in others before, and in others after. The pieces of some stones had adhered together, without forming a united whole; in others, the fusion had been general. The vitrification in these experiments took place very slowly; first appearing as a very thin coat or crust, which afterwards became thicker, and at length, in some species of these stones, penetrated to the centre. This glass gives fire with steel; is compact, extremely pure, transparent, and colourless, or at least very slightly tinged with green, light yellow, or sky-blue. The flint of the Euganean mountains was more refractory to vitrification. It is true, that after the third day of their continuance in the furnace the pieces began to adhere together, but on the twenty-fifth the vitreous coat with which they were surrounded was scarcely two lines in thickness; and

and when taken out of the furnace at the end of the forty-five days, the nucleus of some pieces of flint exhibited a simple calcination. The same was the case with two pitch-stones, notwithstanding a complete fusion had taken place in the other four.

The glass-furnace in which I made these experiments could be of no further use to me, as I have before said, after the forty-fifth day, the fire being then increased for the making of crystal glass. But soon after, another of the same kind was kindled: two furnaces being every year employed at Pavia, the workmen who have worked in one remove to the other, and very nearly the same degree of heat is maintained in both. I resolved, therefore, to transfer from the first to the second furnace, those stones that internally were not completely vitrified, which were thus continued forty-five days more, or, in the whole, ninety days, exposed to the same degree of heat. This prolongation of an equal heat was not inefficacious, the vitrification being still further

ther extended by it in the nucleus of the pitch-stones, and the flint ; nor can I doubt but it would have been complete, had the same heat been continued for a longer time,

These experiments were very instructive. Before I made them, when I saw that a continuance in the furnace of a few days was insufficient to fuse stones, I have been used, in this work, to call them-refractory to the furnace, or infusible ; and, in fact, such they appeared during that time. I was then ignorant of the effect that might be produced by a longer duration of equal heat. Experience has now taught me, that this infusibility may be overcome by the continuance of the same heat ; so that it is now proved, that a long continued heat of less strength is equally efficacious in the fusion of bodies, with a stronger heat of a shorter duration.

After a little reflection on the inefficacy of fire, for the fusion of stones, when its duration is only for a few days, and its
power

power to produce that effect after longer continuance, it appeared to me, that the nature of this difference might be easily explained. This agent at first only calcines stones, depriving them of some of their parts, and more or less altering their structure; but, continuing to act on them, it no longer finds them in their former state, but in part changed; whence its action produces new combinations. In the mean time, other changes take place by the loss of other particles that are volatilized, and hence other modifications arise, from which the stone at last acquires the conditions of beginning fusion. If then a more active fire be applied, it will effect, in a short time, what the less active can only effect after a longer continuance.

If we proceed to apply these facts to the position advanced by M. Dolomieu, that the volcanic fire acts more by its duration than by its strength; we shall see that this fire, though it should be feeble, may, in a long time, liquefy those stony bodies, on which

it would not have that effect, if it were of short duration; but this liquefaction would be accompanied likewise with that of the shoerls and felspars, and the destruction of the structure of those stony bodies. Such effects at least I have observed in the above-mentioned stones. Should it be objected that this observation is not applicable to volcanos, since the matters ejected from the crater of Stromboli, though they incessantly fall back into it again, and are exposed to a long action of its heat, do not lose their primitive characters*; I shall answer, that though this be allowed, it will not prove the want of activity in volcanos, but rather the singular manner of their acting on the substances with which they meet; as we have shown above, and shall again have occasion briefly to show hereafter.

To proceed to the second argument of M. Dolomieu, relative to the sulphur, I observe that, in many parts of his works, he

* See Chap. XI.

considers this inflammable body in volcanos as a true flux; and, at page 157 of his *Descriptive Catalogue of the Productions of Etna*, has these remarkable words: "A stone, extremely ferruginous, being heated red-hot and brought in contact with a roll of sulphur, an effect takes place nearly similar to that produced on a piece of iron, which, in the same circumstances, burns, calcines, and becomes instantaneously fluid, by the action of the sulphur on it."

I shall here relate the methods I employed to ascertain whether sulphur facilitates the fusion of those stones which usually are the base of lavas; such as horn-stones, petrosilices, and shoerls in the mass. I chose such of these as do not require a long time to begin to fuse in the furnace, endeavouring to prove, by some comparative term, whether sulphur facilitated their fusion. I caused, therefore, six crucibles to be made of clay, each a foot and a half in height, seven inches wide at the bottom, but narrower

rower towards the top, where they terminated in an aperture of a line and a half in diameter, having there the form of an inverted funnel. One of these I filled to the top with petrosilex reduced to powder; and the other to three quarters of its height with sulphur in powder, filling the remainder of the crucible quite to the top with pulverised petrosilex. I filled the other four crucibles, in like manner, with horn-stone, and shoerl in the mass, one of each with, and one without sulphur. I was thus enabled to observe the manner in which these stones will fuse in the furnace both with and without sulphur. The sulphur I employed could not be better adapted to the experiment, since it was that of the island of Vulcano. It must be evident that it was necessary each of the six crucibles should be exposed to exactly the same degree of heat, and of this I certified myself by means of the clay cylinders.

After thirteen minutes the sulphur began to exhale from the three crucibles which

contained it, in the form of a thin, expanding smoke, of a reddish colour, which arose from the three funnels. I had purposely left that narrow aperture in the crucibles, since, had they been entirely closed, the sulphureous exhalations would have burst them; and, besides, by the narrowness of the aperture, the inflammation of the sulphur was more preserved. The fumes increased, and continued for a considerable time, and still remained when the hornstone in the crucible without sulphur, as well as in that which contained it, began to fuse; which it did after fifty-three minutes. I did not perceive that the sulphur in the least accelerated the fusion. I obtained a beginning fusion of the petrosilex in the crucible without sulphur after sixty minutes, nor did I find that it took place sooner in the other crucible which contained sulphur, and which continued to fume for fifty-eight minutes. On breaking the two crucibles, I did not perceive any difference in the vitrification of the petrosilex.

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In these two experiments, therefore, the sulphur had not accelerated the fusion of these two stones, nor could I discover that it did that of the third.

As it is the opinion of many that sulphures of iron are the aliment of volcanic fires, and that the sulphur which sublimes from them thence derives its origin, I determined to repeat the same experiments in six similar crucibles, making use of sulphure of iron instead of sulphur.

This sulphur was in a state of decomposition, and abounded with the sulphuric acid. The fact however was, that the fusion of the above-mentioned stones took place as soon in the three crucibles without sulphur, as in the three others that contained it.

It has been mentioned above that M. Dolomieu tells us that, if a piece of sulphur be touched with a red-hot stone, abounding

in iron, this stone, like iron in the same circumstances, becomes fluid in an instant.

I had now an inviting opportunity to make an experiment with lavas when in actual fusion within the crucibles, selecting such as most abound in iron. We have seen that lavas, in general, never acquire, in the furnace, a true fluidity, but only a greater or less degree of liquidity. It is evident that, if the assertion of the French naturalist were well founded, this liquidity must pass into fluidity in these ferruginous lavas when sulphur is burned on them. While, therefore, they were in a state of actual fusion in the furnace, I caused to be dropped into the crucibles liquid and burning sulphur, by means of an iron ladle, which, having a long handle of the same metal, might be introduced into the furnace. At the same time that the liquid and burning sulphur was thus poured into the crucible by another person, and when all the melted lava was covered with it, while it
 boiled

boiled over it, and sublimed in a thick reddish fume, I, with a pointed bar of iron, tried the resistance of the lava to observe whether, as the melted sulphur was dropped on it and evaporated, the surface acquired greater liquidity. But no such effect took place. The same degree of resistance it manifested before the sulphur was poured into the crucible, continued when it was poured in, though this pouring was continued a quarter of an hour; and it remained the same after the sulphur had entirely evaporated.

I made these experiments on seven kinds of lavas, and always with the same result, with respect to the sulphur being the cause or promoter of the fluidity of the lavas.

As the burning sulphur, though aided by the fire of the furnace, was incapable to promote the fusion of these stones, it might very reasonably be supposed incapable to fuse them when it acted on them by its flame alone, animated by a current of air, in

a chemical furnace, as I likewise found by experiment. This flame, in fact, produced no greater effect, when animated by oxygenous gas produced by the mixture of two thirds of flowers of sulphur with one third of nitre.

From the result of these experiments there appears no foundation to believe that sulphur can act as a flux on the stones that pass into lava, or that it facilitates their fluidity.

I shall now proceed to a brief examination of another opinion of M. Dolomieu relative to the fluidity of lavas. It may be reduced to this: That lavas are penetrated by two kinds of caloric (heat): the one communicated to them in the volcanic gulph; the other proper to themselves, and which is developed by a real combustion; that, in consequence of this second caloric, their fluidity lasts much longer than it would if they had only that received from the volcano: whence we may understand why some
lavas

lavas pass over only a very small space in a long time; and that the combustion of lavas sometimes resembles that of urinary phosphorus, and at others produces a true flame, which in many cases is a clear blue, or variously coloured.

It is evident that the existence of such a combustion is principally supported by the effects which are supposed to be produced by it; I mean the variously coloured flame, which M. Dolomieu tells us appears on the surface of running lavas. Had this respectable Naturalist been an eye-witness, I certainly should not have disputed his assertions. But he only speaks in general, and in a vague manner; and I cannot doubt but, had he seen it, he would have described it circumstantially, to give greater proof to so novel an hypothesis. It is true, he promises, in his Introduction to his *Products of Etna*, to prove his assertion by a series of observations; and his work, when published, will certainly be eagerly read by all naturalists. In the mean time, as a sincere lover

lover of truth, he cannot be offended if I adduce some facts that do not accord with the supposition of this flame. I have extracted them from authors who have seen flowing lavas a hundred times, and have described their phenomena with the most scrupulous exactness, and without the least appearance of prejudice: these are, Serao, Father Torre, Bottis, and Sir William Hamilton.

The first, speaking of the lavas from time to time ejected from Vesuvius, remarks, that "when seen by night at any distance, they emit a light, not shining, like a bright flame, but of a dead kind, like that of red-hot substances which burn without flame." When describing circumstantially the lava ejected from the same volcano in 1737, he does not mention a word of its flame.

Father Torre, relating the principal circumstances of the eruption of Vesuvius in 1751, remarks, that "there was no visible
" fire

" fire on the surface of the torrent." And describing the most minute phenomena of the other flowing lavas; he makes no mention of flames proper to them, nor does he say that he saw them burn; only in pages 75 and 76 of the work I have so frequently cited, he says, " On observing by night " the surface of the lava, even in those places " where it was become cold, flames of sulphur were seen to issue in many places, " which immediately became extinguished." But besides that this lava no longer burned, the flames which appeared proceeded from sulphur; and these are frequent in volcanos, but have no relation to the present question.

If we open the quarto volume of Professor Bottis, entitled, *A History of the various Conflagrations of Mount Vesuvius**, we shall find scarcely a page in which we do not meet with the description of some burning lava; but though I have attentively examined that work, I do not find a single

* Istoria di varj Incendj del Monte Vesuvio.

passage

passage in which mention is made of flames attendant on running lavas. It is true, the author frequently uses the terms *inflamed torrent, rivers of fire, &c.* but these are emphatical expressions, and such as I have frequently employed myself; by which he certainly only means currents of lava profoundly penetrated by fire.

Sir William Hamilton, who approached very near the mouth of Vesuvius at the time of a violent eruption, does not say that the lava flamed, but only, that "it had the appearance of a red hot and liquid metal, such as we see in the glass-houses."

With respect to the flames which sometimes appear on lavas, he says, "I have observed upon mount Vesuvius, that soon after a lava has borne down and burned a tree, a bright flame issues from its surface; otherwise I have never seen any flame attending an eruption." And here he obviates the mistake which might arise from taking for the flame of a lava the
smoke

smoke issuing from it, which by night has all the appearance of it.

The observations I made at Vesuvius, Stromboli and Etna, do not in the least differ from those of the four naturalists above mentioned. In my description of a lava moving within a cavern of Mount Vesuvius, I have said "its surface exhibited the redness of burning coal, but without the smallest appearance of flame*." I have noticed similar appearances in two other caverns of the same mountain, and speaking of the lava which flowed above the ground, I remark that "it had a red colour, but less ardent than that of the lava which flowed within the cavern†."

In the boiling lava of the crater of Etna, I likewise saw no flame: it only had the appearance of "a liquid ignited matter‡."

* Chap. I. Vol. I. p. 21, 23.

† Ib. page 24.

‡ Chap. VIII. Vol. I. p. 249.

But

But the furnace of Stromboli, especially, afforded me the most favourable opportunity to discover this flame; both from my very near approach to the ascending and descending lava, and from my having observed it entirely at my ease during the night. It is certain, however, that I saw no appearance of any flame, which I have not neglected to notice to the reader. The following are my words: "The surface of the burning lava within the crater never emitted any sensible flame, not even when the bubbles upon it burst with an explosion; but it shone with a glowing vivid light, and resembled in its appearance melted glass in a furnace*."

I know that, to prove this combustion, M. Dolomieu refers to a lava of Etna which flowed ten years, and only advanced one mile. But I shall first observe, with his permission, that the distance flowed by this lava was not one mile, but two. Such at

* Chap. X. Vol. II. p. 65.

least is the account of Alphonfus Borelli.—

“Deinde, anno 1614, nova vorago supra
 “oppidum Tyssæ seu Rondatici aperta est,
 “e qua effluxit pariter materia ignita cursu
 “tam lento et torpido, ut intra decem annos,
 “quibus perpetuo effluxit, duo tantum mil-
 “liaria pertransierit.”—“Afterwards, in the
 “year 1614, a new gulph opened above the
 “town of Tyssa or Rondatici, from which
 “issued a fiery matter, with a course so
 “slow and heavy, that in ten years, which
 “it continued to flow, it only passed over
 “a space of two miles.”—Secondly, it ap-
 pears to me, that we may conceive the cause
 of the extreme slowness of this lava, with-
 out supposing, with the French Naturalist,
 that it burned, and therefore continued to
 flow so long as the aliment of combustion
 remained in it. It is certain that the velo-
 city of lavas depends, among other causes,
 on the greater or less declivity of the sur-
 face down which they descend; and if a
 current is forced along a horizontal plain;
 and still more if it is compelled to ascend,
 as sometimes happens in mountainous places,

its

its course will be extremely slow; and this may have been the case with the lava of 1614. This slowness of its motion may likewise have been caused by the great dispersion of the heat received from the volcano, which might, in consequence, have become so weak as scarcely to retain the lava in a state of fluidity. Lastly, for I will not omit a remark I consider as of importance, if this principle of combustion were intrinsic to the rocks, and developed itself in open flame in their fusion, it is evident that the same phenomenon would accompany the liquefaction of these rocks in the furnace, in which, however, I never perceived the least sign of combustion or flame.

These observations, it appears to me, must prevent us from receiving with confidence the hypothesis of the French volcanist, relative to the flame produced in lavas, according to him, by a combustible substance they contain, and which burns and consumes in the manner of other inflammable bodies.

bodies. He must, at least, permit me to consider it as absolutely doubtful and uncertain until he shall produce facts sufficient to demonstrate its truth.

Relative to the fires of volcanos, therefore, I consider two things as certainly proved : First, the great activity of the greater part of them : Secondly, that their manner of acting has been hitherto little known to us, and, perhaps, will never be clearly understood. Their energetic force has been demonstrated by numerous and solid arguments, which have not been in the least invalidated by those adduced on the contrary side ; as the difficulties objected in the latter may be easily explained by the singular manner in which these fires act, and of which we have convincing proofs. To these proofs I shall here add a new one.

When I was at Naples, I obtained some specimens of that Vesuvian lava which was observed by Professor Bottis fused and boiling within a small cavity, and which he

found to be penetrated with so great a heat that it suddenly liquefied scoriæ and porous lava which he threw into it. I have stated this fact in Argument II. in favour of the great activity of volcanic fires. On examining these specimens, I soon perceived, from their preserved structure, that the base of this lava was a horn-stone; and the crystallized shoerls it included exhibited in their fracture that vividness which is the property of those stones when uninjured. But both these shoerls and the lava, after a continuance of some hours in the glass-furnace, became glass. How, then, can we explain why these bodies should remain untouched in a most violent fire, and vitrify in one less strong, without supposing that the energy of the former was combined with certain circumstances and principles tending to preserve their structure, but with which we are hitherto unacquainted?

I have thought that sulphurs and petroils give birth to and maintain volcanos, as has been the opinion of the generality of naturalists.

ralists *. It must, however, be confessed, nor do I fear to be contradicted, that such an opinion is very hypothetical, since we are ignorant what really is the aliment of subterranean fires. It is certain that this aliment, whatever it may be, is, when it burns, in very different circumstances from those of our furnaces, which cannot burn without the presence of atmospheric air, of which the subterranean abysses, where volcanic conflagrations begin, are destitute. The islands that have been produced by the action of submarine volcanos are almost innumerable; and new ones have been thrown up even in our times; as, for example, the two which arose in the Icelandic sea, in 1784, in a part where the water was five hundred feet deep. How, then, can we reasonably suppose the existence of our air at this prodigious depth below the sea, where the substances productive and alimentary of volcanos take fire? We must despair of ever understanding the nature of these fires, or

* See Chap. XI.

admit the development of oxygenous gas, which we have seen elsewhere is not improbable *. Were this gas pure, the fire, animated by it, would vitrify the whole, and form one homogeneous mass; but with how many heterogeneous substances must it not be united, from which combination probably result its singular, and, by us, little understood operations, which manifest the most powerful activity, at the same time that it leaves uninjured the bodies it fuses! Numerous, and very different from each other, are the aëriform fluids which, no doubt, exist in these recesses; such as the carbonic acid gas, the muriatic, hydrogenous, and azotic acids, &c. since of these volcanos are never destitute. It is evident that such fluids will, more or less, modify the virtue of oxygenous gas, from which will arise proportionate modifications in the fires animated by it, and in the stones on which they act. The salts they meet with, and which we frequently find adherent to

* Chap. XXI.

the mouths of volcanos, such as the sulphates of alumine and iron, and the muriates of ammoniac and soda, it is probable, likewise, concur to produce such modifications. It is true that different saline substances facilitate the vitrification of stones ; but we know not what products may arise from the simultaneous combination of various salts, especially if they suffer decomposition in the burning volcanic gulphs.

It is not improbable that water united with fire may produce combinations impossible to be attained by human art. This was the opinion of Faujas ; who was convinced that there was a kind of mystery in the elaboration of the products of volcanic fires, when compared with those produced by our common fire. I shall here transcribe his remark on this subject, and conclude this chapter with the authority of that justly celebrated volcanist ; “ I almost incline to
 “ be of opinion that the aqueous fluid, raised
 “ to a degree of ebullition and incandescence
 “ of which our feeble furnaces can give us no

"idea, sometimes concurs with the inactive
 "and concentrated fire which exists in the
 "immense volcanic caverns, and that from
 "this concurrence result a multitude of
 "combinations hitherto unknown to us,
 "which take effect on the stones and earths
 "that remain perhaps whole ages in these
 "burning gulphs, where the fire, intent to
 "destroy, has for its adversary the water,
 "which incessantly creates and opposes to
 "it all the forms and modifications of which
 "the matter is susceptible."

CHAP.

CHAP. XXIV.

CONCLUSION OF THE ACCOUNT OF THE
EOLIAN ISLES, IN REMARKS ON VA-
RIOUS SUBJECTS NOT VOLCANIC.

I. Lipari.—*Population of that island—Useful vegetables produced in it; among which the wine furnishes the most considerable branch of its commerce—Celebrated malmsey of this country—Manner of making that wine—Scarcity of corn, which might be rendered more plentiful by adopting a different system of agriculture—Great abundance of Indian figs in Lipari and the other Eolian islands—Delicious taste of their fruit—Description of that shrub; and remarks on the facility with which it may be multiplied—Project to render it much more profitable by making use of its leaves to nourish the cochineal insect, as*

silkworms are fed with the mulberry leaf—
Fishes and coral found near the shores of
Lipari—Account of a physeter, or kind of
whale, observed by the author in that sea
—This fish, though internally organized
nearly like others of the mammalia class,
could remain under water a much longer
time than they usually can—Very few cattle
of any kind in Lipari—Cause of this scar-
city—Rabbits the only wild quadruped in
this island—Manner of hunting them with
the ferret—Stationary birds at Lipari but
few, nor any birds of passage, at least at
the time the author was there—Some
which with us are birds of passage, there
stationary—Curious manner of taking
swallows, in the streets of the city, in win-
ter—Branches of foreign commerce which
have begun to be introduced at Lipari
within these few years—Remarks on the
assertion of Strabo, Diodorus, and Dioseo-
rides, that Lipari derived a considerable
profit from the sulphate of alumine (alum)
—Political and ecclesiastical state of Lipari
—Physical

—Physical and moral character of the
Liparese—Brief account of the city of
Lipari.

II. Stromboli.—The great heat felt in this
island not to be attributed to its volcano,
but the sun—Nature of this climate—
Frequency of tempests—The shore of
Stromboli destitute of a harbour—Vessels
used by the natives to navigate these seas—
The great quantity of fish taken in the vi-
cinity of this island, probably a consequence
of the heat of its volcano—Plants which
grow in this island—Malmsey the princi-
pal product of the country—Vines, and the
manner in which they are defended from
the wind—Number of inhabitants—The
natives not fearful of their volcano—Hos-
pitality of the Strombolese—Their charac-
ter—Account of a spring, the only one
in the whole island—Animals found in
Stromboli.

III. Vulcano.—An uninhabited island—
Great quantities of sulphate of alumine
(alum)

(alum) once extracted here—Difficulty of the extraction of it at present—More profit might be derived from planting vines.

IV. Saline.—Abundance of grapes in this island—Spring near the shore, probably supplied by rain water—Muriate of soda (sea-salt) extracted from a small lake contiguous to the sea—Means of procuring this salt—Curious phenomenon observable in this lake, when the sea water enters it.

V. VI. Felicuda and Alicuda.—Their population—The houses built, not on the shore but at the foot of these mountainous islands, but about half way up their declivity, that they may be less exposed to the incursions of the Barbary pirates, who formerly have frequently landed there in search of plunder—Such incursions sometimes still made at present—Well-grounded fears of travellers in sailing round these islands—Useful vegetables in Felicuda and Alicuda—The corn of Alicuda excellent, though produced but in small quantity—Extraordinary industry of

of the inhabitants in its cultivation—Fishing-boats of these islands—Ridiculous and superstitious practice of the inhabitants when a husband or wife dies—Boast of the people of the Lipari islands in general, that those islands contain no kind of serpent—Physical reason of this fact—Extreme scarcity of insects there, and the cause—Enviably tranquillity and content of the inhabitants of these islands—Salubrity of the air—Advantages experienced from that salubrity, by the author, during his stay there—Comparison between this very pure air, and that of some of the low plains of Lombardy.

TO complete my observations relative to these islands, I shall now proceed to give a concise account of their population, the character, manners and customs of the inhabitants, their commerce, the animals stationary and migratory found in them, and other analogous objects; agreeably to what was proposed in the Introduction to this work.

I. LIPARI.

THIS island is the largest and much the most populous of those called the Eolian isles, the number of its inhabitants amounting to between nine and ten thousand; a considerable part of whom reside in the city of the same name, which is very ancient, as it appears from historical records that it existed before the war of Troy*.

If the island of Lipari be divided into four parts, about two and a half will be found to be cultivated, and the remainder overgrown with wood and barren. These barren tracts, however, continually diminish, and are converted into fruitful fields, from a kind of necessity arising from the continually increasing population of the island.

Lipari produces cotton, pulse, and olives, though in but small quantities. The corn produced there, and which is of an excellent quality, amounts annually to fifteen hun-

* See Chap. XVI.

dred Sicilian *salme* *, or two thousand at most, and is scarcely sufficient to supply the city.

Among the useful productions of this island the principal are grapes; of which there are several kinds. The first furnishes the common wine which is drunk in the island, and of which there is so great an abundance that they export annually two, and even three, thousand barrels (*barilli*) of it without the least inconvenience. They press the grapes on the spot where the vines grow, and carry the must, in leather bottles, to their respective houses on beasts of burthen.

The *passola* and *passolina*, as they are here called, are two other kinds of grapes that are dried. The last is that sort which is usually called the Corinthian grape. Of this they commonly sell ten thousand barrels annually; and of the other about twelve thousand.

* A *salma* contains 16 *tumuli*, the *tumulo* from 20 to 22 *rotoli*, and the *rotolo* 2½ pounds.

Stolberg's Travels, Vol. II. p. 306.

From

From a fourth kind of grape is made the famous malmsey of Lipari, which name alone is sufficient for its eulogium. It is a wine of a clear amber colour, at once generous and sweet, which fills and warms the mouth with an agreeable fragrance, and a return of sweetness some time after it is tasted. But, as Nature usually bestows on man her most precious gifts with a sparing hand, this grape is here scarcer than any other; and does not furnish at most more than two thousand barrels annually, which the Liparese sell for foreign markets, as they do also the passola and passolina. During my stay in the island, I could scarcely procure a sufficient quantity to revive my spirits after my fatigues, and carry with me a specimen of this rare and delicious liquor to Pavia.

I was desirous to learn the method employed by the natives in making malmsey. It is as follows: They do not gather the grape until it is perfectly ripe, which is known by its beautiful yellow colour and
the

the sweet taste it acquires. When the grapes are gathered, the rotten and spoiled berries being first picked out, they are exposed to the sun on mats made of reeds, for eight or ten days, or sometimes longer, till they are dried. They then place them on a clean stone floor, surrounded with a kind of low wall, about two feet high, where they crush them, first with a stone fastened to the end of a small staff or handle, and afterwards with their naked feet, till all the juice is expressed; which is then let run off through an aperture to another similar floor, the sides of which are higher; and here the must is all collected. It is afterwards drawn off into vessels in which it is left to ferment, till it is perfectly depurated and become fit to drink, which it is by the following January.

The vintage is in the month of September, at which time the Liparese, leaving the city, resort in companies to some cottages near the vineyards, where they remain during the gathering of the grapes, resigning

ing themselves to mirth and innocent pleasures ; and the voyager, who chances to approach the island at that season, finds his surprise not a little excited by the numerous lights which are exhibited during the night, and illuminate and embellish these rustic habitations.

Another plant, if it does not form a branch of foreign commerce, is yet of some domestic utility to the Liparese : I mean the *Opuntia*, commonly called the Indian fig, (*Cactus Opuntia* Lin.) This shrub, with us, will not live through the winter, except it is preserved in hot-houses ; and, being in a climate not congenial to its nature, grows to no great height, and produces but few fruits, and those small and of no worth. At Lipari, on the contrary, and in the other Eolian islands, it thrives so well that it usually grows to the height of ten, twelve, and sometimes fifteen feet, with a stem a foot or more in diameter. The fruits, which are nearly as large as a turkey's egg, are sweet, and extremely agreeable to the palate,

palate, and of very easy digestion. When unripe, their skin or rind is green; but when ripe, of a reddish yellow. This plant will take root and grow, in a surprising manner, in almost any situation which has a favourable aspect, and the most favourable is the southern. It thrives alike in the poorest and the richest soils, the fissures of lavas, among the ruins of ancient buildings, on fragments of dried mortar, and in the crevices of walls: It is well known that the fruits grow at the edges of the leaves; the number on each leaf is not constant, but they are frequently numerous, as I have counted two-and-twenty on a single leaf. They begin to ripen about the beginning of August, and continue to November. In some situations, indeed, where they enjoy the benign influence of the sun, they remain through the whole winter; and even where they have not that advantage, they may be preserved ripe and in good condition during the winter, by being gathered green in autumn, and left attached to the whole or a part of the leaf, the juice of the leaf, which

is always thick and pulpy, affording a nutriment to the fruit.

The inhabitants of Lipari eat these fruits during several months of the year ; for, as there is great abundance of them, they are sold at a very low price. Besides those which Nature produces here spontaneously, the Liparese industriously cultivate great numbers of these Indian figs, and the method of multiplying them is very easy. It is well known that this plant is propagated by means of the leaves, which are of an oblong shape, narrower at one extremity than at the other, and resembling a peel or shovel, by which name they are called by the Sicilians. Every leaf is thick and pulpy, and each side of it scattered over with small buttons or knobs, from which arise a great number of little prickles, with a large one in the centre, of the length of an inch. If these buttons only touch the earth, they take root, let the ground be what it may. The leaf which has taken root puts forth other leaves that again produce others ; and, from
being

being flat, as it was at first, becomes, in time, round, and forms a trunk which lengthens and thickens in proportion as the other leaves grow and multiply. For the stem or trunk of the Indian fig, which, as I have already said, is sometimes more than a foot in diameter, is only a series of leaves in an upright position, and adhering to each other.

Such are the different vegetable productions of the island of Lipari, which, however, with respect to commerce, may be reduced to one only, I mean the grape. Corn, as we have seen, from its scarcity, scarcely deserves to be mentioned; but this might be grown in far greater quantity were the system of agriculture prevalent at present in this island changed. It is here the general practice to raise the vines two or three feet above the ground, and with poles and reeds to form a kind of squares by which they are supported. The consequence is, that the vines with their branches and leaves form a kind of covering, impenetrable to

the rays of the sun, which renders the soil below entirely barren. Several of the natives of Lipari have had the good sense to perceive the inconveniences of this practice, and, disregarding the prejudices of their countrymen, have changed these pieces of barren ground into fruitful corn-fields, without the least detriment to the fruit of the vine. The Abbate Gaetano Trovatini, whom I have elsewhere mentioned with deserved commendation, is among the number of the few who have made this liberal experiment. I saw a field of his which, though not very extensive, nor of a better soil than others, produced both a plentiful harvest and an abundant vintage. Instead of planting the vines in the narrow squares there called *pergole*, he has ranged them in parallel espaliers with wide interstices of ground between them, in which he has sown corn in straight furrows, after the method of Du Hamel. Thus the air and the sun exert their influences freely between the espaliers, and not a foot of ground is lost to cultivation. The grain yields a luxuriant
crop,

crop, and the vines are, at the same time, not less fruitful than those of the neighbouring grounds, where the old method is adhered to. It is true that Trovatini, like Caius Furius Crefinus in ancient times, is surveyed by many with an eye of ill-natured envy, when they compare the wretched appearance of their grounds with the copious produce of his. But, even while I was there, several of his neighbours had begun to imitate his example. It is much to be regretted that Don Giuseppe Cippola of Palermo, the late bishop of Lipari and the adjacent islands, did not live some years longer. That worthy prelate seemed to have been born for the improvement of the soil of those countries, which before were wild and little productive. The number of olive-trees which he caused to be planted is incredible. I found above three thousand in Panaria alone. He also introduced mulberry trees there, which have thriven extremely well. I saw one in a court-yard, planted eight years ago, which, for size and strength, did not in the least yield to ours

of the same age, though the latter have the advantage of a more suitable soil. He has likewise enriched the island with another species of the Indian fig, brought from Palermo, the fruit of which is red and extremely delicious. I sincerely wish his successor, who is unknown to me, may follow his excellent example. Since I have again mentioned the Indian fig, I cannot avoid noticing an idea which has occurred to me, and which, should it ever be carried into effect, must be productive of great advantage both to Sicily and the Eolian isles. The cochineal insect (*Coccus cacti* Linn.) is bred and collected in Mexico, and other Spanish provinces of South America, and the commerce carried on in it is estimated at many millions of dollars annually. Might not the advantages derived from this precious drug be shared with Mexico by the Lipari islands and Sicily, which may be considered as the most southern part of Italy, from which it has been separated by the irruption of the sea
that

that produced the strait of Messina? To effect this, two things, indeed, are necessary; the plant on which the insect lives and propagates, and the insect itself. The plant is that usually called the Indian fig; and which is found in such abundance in the Eolian isles and Sicily, where I have seen the foot of Etna covered with it. Travellers relate that the opuntias of Mexico, where they are cultivated with the greatest care, grow to the height of eight feet, and that the leaves of some of them are nearly a foot in length. We have said that those of Lipari, and the same is true of the rest of the Eolian isles and of Sicily, rise to a greater height, and have leaves more than a foot long. If, therefore, these plants thrive as well in Sicily and the Eolian isles, as in America, and, perhaps, better than they do there, why should not the cochineal insects, which feed on them, thrive equally in those countries? Will not the silkworm, though originally from India, live and multiply in every country where it can be supplied with the

leaves of the mulberry tree? The only difficulty, in my opinion, would be the conveyance of this useful insect to so great distance, principally because it could not be removed in the egg, since it is viviparous, and not oviparous. It should be observed, however, that, as the Americans perpetuate the cochineal by means of the leaves of the opuntia, it, no doubt, would continue to live on the leaves of that plant; which might be brought, growing in large vessels filled with earth, from Mexico to Sicily. The important advantages to be derived from the success of the experiment, at least, would sufficiently justify the labour and expence of the attempt. I am not ignorant of the jealousy and reserve with which the possessors of this insect, which is so valuable to them, guard it from foreigners to prevent their stealing it. Such a theft has, however, been practised on them to the advantage of some of the French provinces. I know, likewise, that the hint I have here given, should it ever be carried into effect, would

not

not be agreeable to the political views of Spain; but an Italian and a philosopher may surely be permitted to propose it.

I shall now dismiss the vegetables, and proceed to say a word of the fishery of Lipari, than which nothing can be more wretched. Not that the sea does not contain fish; but because there are but few there who follow fishing as an occupation, and even of these the greater number are not provided with the necessary implements. They only use the line and hook, and the *sciabica*, a kind of net, which they throw to a considerable distance into the sea, and then drag on shore. This mode of fishing is only used in the harbour, and not very frequently, at least in the summer, though I have been told that in winter it is more common, as they are then without other employment. I have often been present at their throwing the net, less from curiosity than to procure fish for my small table: but those days proved but unpropitious to the fishermen, and not less unlucky to myself; since after three or four
throws

throws they either caught no fish, or those so few and small, that, had I nothing else to eat, I might have died with hunger.

In June and July they likewise fish for coral, both round the shores of Lipari, and at Vulcano. When I was there, I procured a rare specimen, consisting of a branch of coral which had grown on a volcanic enamel under the Castle of Lipari. Fifteen barks, I was told, are usually engaged in the coral fishery; but, either because they are ignorant of the proper methods of detaching this valuable animal-plant from the rocks and caverns of the sea, or because they are not sufficiently expert in the use of them, this fishery is very unproductive. In the two months above mentioned, every bark carrying eight men fished up ten or fifteen *rotoli* of coral; and the *rotolo* contains two pounds and a half, and the pound twelve ounces.

Formerly coral was likewise fished at the *Secca di Santa Caterina*, a place distant ten miles from the harbour of Lipari; but some

barks having been wrecked there, the bishop of that time, Father de Francisci, a Dominican, fulminated his excommunication against any bark which in future should have the temerity to attempt to fish in that place.

In my various maritime excursions round the Eolian isles, I never met with any of those smaller cetaceous fish which are frequently found in other parts of the Mediterranean. But one day when the sea was calm, while I was sailing between Panaria and Vulcano, a large cetaceous fish of the genus of the *Phyfeter*, and which from a long fin on the back I judged to be the *Tursio* of Linnæus, suddenly rose to the top of the water. It approached within about seventy feet of my boat, and I had sufficient opportunity to observe it with some attention. It is well known to mariners as well as naturalists, that dolphins, phyfeters, and whales, properly so called, have need of respiration from time to time, and therefore frequently rise to the surface of the water with the upper part of their bodies, and throw up, from one or more apertures they have

have in the head, one or two ejections of water accompanied with the air they have taken in, and inhale fresh air. The cetaceous fish of which I now speak did the same; and when he came to the surface of the water, and drew along the half of his body above it, he was so near that I could estimate his dimensions with the eye. He was at least twenty-eight feet long, and the breadth of his body, where largest, not less than eight feet. The caudal fin was eight feet in length, and the dorsal two. At every expiration, a hissing sound was heard of air and water, which he ejected to the height of eight or nine feet. A little before he made this ejection, he raised nearly the half of his huge body above the water, but after five or six minutes again sunk and disappeared. I wished to observe the interval of time between one ejection and another, as the animal continued this alternation for a full quarter of an hour. I perceived they were repeated after every sixteen or seventeen seconds, and I flattered myself that I had ascertained with sufficient accuracy the space of time that one of this species of fish can remain

remain under water without being obliged to rise to the surface and inhale air; but I soon found this calculation erroneous. After my curiosity had been gratified with this scene about a quarter of an hour, the animal raised his tail, vertically, about three feet above the water, and, plunging directly down, disappeared; nor could I again discover him, though both I and the four mariners who were with me watched with the utmost attention during a quarter of an hour: and certainly had he, in that time, raised himself to take in air, we must have seen him, from his great bulk and the calmness of the sea. I then perceived that this animal, though in his organization in a great measure resembling the class of mammalia, and therefore, like them, under the necessity of respiring, could yet remain a much longer time under water than they can.

But if aquatic animals are of little advantage to the inhabitants of Lipari, their land animals are nearly of as little. Both large
and

and small cattle are there extremely scarce; and the few oxen and cows which are slaughtered there, are brought from Sicily, and are very lean. This is entirely to be ascribed to the poverty of the pasturage. The Liparese cultivate themselves the small portions of land they possess.

With respect to wild quadrupeds, the country produces only rabbits, which make their burrows in the mountainous parts, where the volcanic matters, principally of the tufaceous kind, permit them to dig with their feet. They are hunted with the ferret (*Mustela Furo* Linn.), and the chase is very amusing. Though this animal be originally from Africa, it will live and propagate in the southern countries of Italy. It is about the size of the common cat, and in its make something between the weasel and the pole-cat. I have seen them extremely tame at Lipari, where they breed as fast in the houses as when wild. The sportsman who goes to catch the rabbits, takes with him the ferret, in a cage, and a dog. The latter,

latter, when he sees the rabbit, follows him to the hole in which he takes refuge ; or, if he is under ground, discovers him by the scent, and stops at the mouth of the burrow. The sportsman then puts the *capestro*, a kind of muzzle made of packthread, on the ferret, that he may not bite the rabbit ; as otherwise he would kill it in the hole, and, after having sucked the blood, leave it there. Being unable to seize it, he only scratches it with his claws, and terrifies it till it endeavours to make its escape out of the burrow, and is taken in a net placed for the purpose. The ferret follows it out, and is again put into the cage.

These rabbits are smaller than the tame ones, and, like others that are wild, are of a grey colour. Not that they are originally such ; since it is within memory that they were first brought there by one of the natives, where they have, as is usual with them, multiplied prodigiously. But Nature, put under restraint by man, never fails to restore to animals which regain their liberty,
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the size and exterior habit of body which they had in their original state.

The birds stationary here are but few. They are the partridge (*Tetrao Perdix Lin.*), the greenfinch (*Loxia Chloris Lin.*); the sparrow (*Fringilla domestica*), the goldfinch (*Fringilla carduelis*), the horn-owl (*Strix Scops*), and the raven (*Corvus Corax*). The latter is usually found about the cultivated fields near the stoves, and on the steepest rocks, though sometimes in places sufficiently accessible for the young ravens to be taken.

Of those kinds of water-fowl which migrate from one sea to another, according as they find food in greater or less plenty, and pass indifferently from the salt water of the sea to the fresh of rivers, lakes, and ponds, such as the different kinds of sea-gulls (*Lari Linn.*) and the cormorant (*Pelicanus Carbo*) I did not see one here. Indeed it is very rarely that any kind of water-fowl is seen in the Eolian isles.

It

It is not the same with the birds of passage. In April the turtle-dove (*Columba Turtur*) and the quail (*Tetrao Coturnix*) arrive here, and stay a few days. They come in the same manner in September. Several kinds of swallows are common here (*Hirundo rustica, urbica, apus, melba.*) The two latter make their nests in the fissures of the rocks, and in the highest walls of the city of Lipari. When I left that city, which was on the 15th of October, some swallows of the first and last species were flying over it. I shall likewise observe, that on the night of the 13th of the same month there was a dreadful tempest with lightning, rain and hail; and the next day, early in the morning, a strong south-west wind blowing, I saw in the air, over the Castle of Lipari, at least a hundred common house-swallows, though they soon after disappeared. Reaumur's thermometer, that morning, stood at $15\frac{1}{2}$ degrees above zero ($67\frac{1}{2}$ of Fahrenheit).

In some conversations relative to swallows,
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lows, which I had with Doctor Trovatini and several other persons at Lipari, they related to me a fact which I had before heard at Stromboli, and shall again mention when I come to treat of that island. It is that in winter, and when a sciroccal or warm southerly breeze blows, swallows of one or other of the four species above mentioned are frequently seen to skim the ground in the streets of the city, and are then easily knocked down with long sticks by children, as they are extremely wet. The two latter kinds are even taken with hooks and lines fastened to the extremity of a long reed. A small feather is fastened over the hook, and the boy who holds the reed, conceals himself behind the corner of a street, and waves the feather in the air. The swallow, accustomed to catch insects as it flies, takes the feather and is caught by the hook.

From these observations we cannot but conclude, that these swallows do not pass into Africa at the approach of winter, as many have believed, but that they more
swol
VI probably

probably remain in the island, and issue from their retreats in the warm days of winter in quest of food.

I saw likewise at Lipari, while making the circuit of the island by sea, a fifth species of swallow; the swallow of the bank (*Hirundo riparia* Linn.). This bird is so denominated from building its nest in the banks of rivers, and sometimes the shores of the sea. I observed several of these swallows flying about the rocks of tufa, which descend almost perpendicularly into the sea; and having stopped there some time with my boat, I saw more than one of them go into, and come out of the holes they had made in the tufa. I was told by the people of Lipari, that this kind of swallow appears in March, and disappears in October.

In the Introduction to this work I have mentioned that it was my intention to add to the observations I should make on the swallows of Lipari and Sicily, others which I had made on the same species of bird in

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Lombardy;

Lombardy ; which addition would not have been so long, but it might have been here conveniently subjoined. But having afterwards more fully considered the subject, and made new and various experiments to elucidate the great controversy, whether swallows remain torpid during the cold weather, of which I have slightly treated in my other works (see my Annotations on the Contemplation of Nature ; and Tracts on Animal and Vegetable Physics *) ; and having afterwards extended those experiments to other animals which are in like manner torpid in winter, and especially those whose blood is cold, as the common hedge-hog (*Erinaceus Europæus* Linn.), the marmot (*Mus Marmota*), the dormouse (*Mus avellanarius*), the bat (*Vespertilio*), I found my matter so increase on my hands, that I determined to publish my observations on this subject separately, after having finished the work in which I am at present occupied.

* Annotazioni alla Contemplazione della Natura. — Opuscoli di Fisica Animale e Vegetabile.

We

We will now proceed to notice some other particulars relative to Lipari and its inhabitants. Foreign commerce has begun to be introduced into the island by the mariners; most of whom traffic in what they call galantry-wares. They every year buy, at the fair of Sinigaglio, linen, muslins, veils, and other commodities of that kind, to the value of from thirteen to fourteen thousand Sicilian *oncie**, and sell them at Messina, Catania, Palermo, and other parts of Sicily. This trade is very advantageous to the country, and many have acquired considerable wealth by it. It has, however, considerably diminished the fishery, and raised the price of fish.

Strabo, Diodorus, and Dioscorides, write that the sulphate of alumine (alum) was

* Count Stolberg, in his Travels, lately published, says the *uncia* of Sicily is worth three rix-dollars and nine good groschen; or about eleven shillings and nine-pence. The German translator of this work estimates the *uncia*, I know not on what authority, at six dollars.—T.

procured in great abundance at Lipari. The truth, however, is, that none whatever of that salt is now extracted in the island. I have passed over almost every foot of ground in it, and only found some traces or efflorescences of it, as I have mentioned in the proper places, which, with respect to profit, would not pay the labour of collecting. We must therefore conclude that the vein of this mineral has either been exhausted or lost; or that the Liparese procured it, not from their own island, but the neighbouring one of Vulcano, which is still rich in this sulphate. The latter is, perhaps, the most probable explanation of the authorities above alleged.

The political administration of Lipari is composed of a criminal judge, a fiscal, a governor who has the chief authority both in military and civil affairs, and who is commonly an old invalid; and a civil judge.

The bishop, seventeen canons of the first order, and fourteen of the second; and from
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a hundred and twenty to a hundred and thirty priests, form the ecclesiastical establishment.

The natives of this island are not wanting in natural abilities, but in the cultivation of them. The Liparese are, in general, of a prompt and lively wit, ready to learn, of acute penetration, and extremely desirous of obtaining knowledge. Hence, when any learned stranger visits their island, there is no end to their questions and enquiries. They willingly become his guides to their stores and baths; and there is not one among them who is ignorant that his country was once produced by fire. The seat of the court of King Æolus is contested in the Eolian isles, as the birth-place of Homer is in Greece. He is claimed by each of the islands; but the people of Lipari are fully persuaded that the royal residence of this petty sovereign was in their island; and those among them who have some little tincture of literature, can cite the authority of Ho-

mer and other writers in proof of their assertion.

A beggar is scarcely ever to be found in Lipari; for even the poorest persons have some small piece of ground which they cultivate, and by the produce of which they live.

The natives are usually robust, strong, rather of a large size, and comely. When young they have fine complexions; but fatigue will diminish every kind of beauty, even that of the fair sex. This change is greatly accelerated by the heat of the sun; the effects of which are conspicuous in their tanned skins and swarthy countenances.

If it was a disgrace in Greece to be unable to swim, it is not less shameful in Lipari and the other Eolian isles, to be ignorant either of that art, or that of managing the oar, or steering and handling the sails of a vessel.

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The priests are very expert in every exercise of this kind. The greater part of them have, like the sailors, their arms or hands marked with black indelible stains representing either the crucifix or some saint. I knew, at Lipari, a man of considerable property, and who was honoured with the title of Baron, who was marked in this manner, having formerly been a mariner.

The city of Lipari is not of an extensive circuit, and consists rather of narrow alleys than streets. The castle is surrounded with a wall on which are mounted a few cannon, and is defended by a small garrison. The houses are very indifferent buildings, but three edifices are distinguishable from the rest. These are the palace of the bishop, the house of the governor, and the cathedral church. The latter contains very valuable sacred utensils, and a great quantity of plate and silver images, among which is the statue of St. Bartholomew, their patron saint. These have been collected entirely at the expence of the people, and the value of this treasure

is said by those who understand it to amount to ninety thousand Neapolitan *scudi* *.

II. STROMBOLI.

THOUGH both Stromboli and Lipari lie nearly under the same degree of latitude, or 38° N. the former is much hotter, in summer than the latter; especially near the sea, on account of the strong reflection of the rays of the sun from the large tracts of sand. It does not appear probable, however, that this heat is to be attributed to its volcano, since, excepting a few places near its mouth, if we dig into the earth, we find the ground less warm at some depth than on the surface.

The winter here is always mild; it never freezes; and snow, which is seldom seen, if it fall one day, melts the next. Its greatest depth is about two inches; and it is related as a prodigy that, some years since, snow

* The Neapolitan *scudo* is worth about 4s. 3d. T. fell

fell on the first of November, to the depth of a palm (or nearly a foot). On the summit of the mountain, indeed, snow falls more frequently, and sometimes will remain for a fortnight ; which proves the height of the mountain to be very considerable.

The sea round this island is frequently agitated by storms, and the fact I am proceeding to mention will show to how great a height its raging billows beat.

About a mile from the land, on the north-east side of the island, rises a spacious naked rock, called the Rock of Stromboli. It consists of one entire piece, has rugged points at the top ; and its base, where it is washed by the water, is about a quarter of a mile in circuit. Its greatest height is three hundred feet. This rock is a huge mass of lava, which, probably, once was joined to the island, and has since been separated from it by the violence of the sea. The natives of Stromboli have observed that, in very great storms, the billows rise to one half the height
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of this rock ; and some of them have assured me that they have twice in their time seen the waves rise above the top of the rock. As, therefore, in general, the agitations of the sea are only a consequence of those of the air, we may form some conception of the fury of the winds, which are here more violent than in any of the other Lipari islands. These hurricanes, which frequently arise on a sudden, lay waste the plantations, and wreck the barks exposed to their fury. To avoid as much as possible the effects of their violence, the houses here are built very low.

The shore of Stromboli has neither port nor harbour, and vessels can only seek some little refuge, in case of heavy storms, on the back of the island. Large ships, except compelled by necessity, never anchor there, from fear of running on sand-banks. The vessels employed by the natives for their own occupations are feluccas, which, being extremely light, are easily drawn up on land, and as easily launched again into the sea.

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The fish here are very plentiful and large, especially the sea-eels and murenas; and, during my short stay in this island, I saw a greater quantity taken than during the whole time of my continuance in all the other Eolian isles. They are, likewise, of an excellent taste. This abundance I am inclined to attribute to the volcano, which has continued incessantly burning from time immemorial; and which, extending to an immense depth, must necessarily communicate a part of its heat to the submarine base of the mountain, and to the waters that surround it, in the gentle warmth of which the fish find a more agreeable place of resort, and perhaps propagate in greater numbers than elsewhere. The fishery, however, produces here no branch of commerce, and only serves to supply the island, principally the foreigners who visit it; as the natives usually live on salt meat, and strangers can rarely find any food so agreeable to their palate as fish.

The vegetables that grow in Lipari are
found

found here likewise, and nearly in the same proportion. Malmsey is the greatest article of traffic of the people of Stromboli; they convey it in barrels to Lipari, where they find a ready sale for it. The vines producing the *passola* and *passolina* grape, and that from which the malmsey is made, grow on the sea-shore; and those for the common wine, on the sides of the mountain. Some of them are fastened to trees; but they are all planted in vineyards; and, where these are situated high, they are surrounded with thick reeds, which at once support and defend them from the wind. The vines form a chain to the north-east, and are all planted in volcanic sand.

The habitations of the islanders are built in the same part, and under the same aspect. They are an irregular assemblage of cottages and fishermen's huts. The population of the island amounts to about a thousand persons, and has been for some time increasing; in consequence of which exertions have been made to enlarge the cultivable ground
by

by clearing away the woods. They have no fear of their volcano. Neither they nor their fathers having ever seen torrents of lava burst forth from its furnace and spread desolation around, as has happened from time to time at Etna and Vesuvius; they survey its more constant fires with an eye of indifference and security.

Mr. Brydone, in his Tour through Sicily and Malta, tells us that, notwithstanding his great desire to visit this volcano, the only one of its kind, he did not venture to land at Stromboli for fear he should be ill used by the inhabitants, whom he believed to be little other than savages. On the contrary, M. Dolomiéu was very civilly received by them. The treatment I received from them, and the conversations I had with them, likewise convince me that the English traveller must have been very wrongly informed. The character of these islanders is nearly the same with that of the inhabitants of other villages at a distance from, and having no communication with, populous cities; I mean

mean they are simple, honest, and, having but few ideas, are contented with the little they possess. Their longest journey is usually to the city, which, though it is small, appears to them wonderfully magnificent; and, when they first enter it, they are affected like Dante's rustic.

" Non altrimenti stupido si turba

" Lo Montanaro, e rimirando ammira,

" Quando rozzo, e selvatico s' inurba."

" Thus the rude clown who, for the first time, views

" Of some throng'd capital the wealth and pride,

" Gazes with open mouth, in wonder wild."

A little above the base of the mountain, on the east side, is a small spring, the scanty supply of fresh water from which would be inadequate to the wants of the inhabitants, were it not for a more copious and inexhaustible stream at a little distance from it, which furnishes them with water to dispel their thirst, and without which they could not exist, when, in summer-time, the rain-water they have preserved in their cisterns is entirely exhausted. M. Dolomieu, who visited

visited this fountain, supposes it to owe its origin to evaporation caused in the mountain by volcanic heat and succeeded by condensation at a certain height, it not appearing to him possible that this spring should have its reservoir in the higher parts of the mountain ; as these are composed of sand and porous stones, and, therefore, are unfit to retain water. This hypothesis is certainly both ingenious and probable ; but may not another be equally probable which supposes this spring to be supplied from the summit of the island, where the earth being sandy and full of pores, the rains easily penetrate it, and, collecting in the cavities below, form a mass of waters at all times sufficient to supply the spring ? According to this hypothesis, the reservoir will not be on the surface, but in the internal part of the mountain. The objection that the heat of the volcano would reduce such a body of water to vapour will be found to be of little weight, since the spring is more than a mile distant from the crater ; and it is very probable that the activity of the fire does not

extend so far ; indeed it seems almost certain ; for we do not perceive for a considerable space around it, notwithstanding the porosity of the earth, the slightest trace or indication of those fumes which are the most certain indication of subterranean fires. In fine, the origin of this spring, which never fails, can only be explained in the same manner as that of other fountains of fresh water in other islands.

We find here no stationary birds whatever. Attempts have been several times made, but in vain, to naturalize partridges here. The experiment has succeeded better with rabbits. Those formerly brought have multiplied, and continue to multiply ; living in their natural wild state, in the woody part of the island. The musket and the ferret are their only enemies.

The birds of passage are the same as at Lipari. When I was at Stromboli in the beginning of October, I saw three swallows (*Hirundo rustica* Linn.) flying over the island ;
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and several of the inhabitants assured me that they frequently re-appear in winter, when a warm wind has rendered the air warmer than ordinary.

III. VULCANO.

THIS island is not inhabited, nor is it remembered that it ever was. It is more than probable that its numerous eruptions have occasioned it to be thus deserted. It is not, however, more than a century since it was of considerable utility to the people of Lipari from the quantity of sulphur and sulphate of alumine (alum) they procured from it; bringing away annually, if we admit the estimate of Pietro Campis *, to the amount of four thousand *cantara* † of the

* Disegno Istórico della Città di Lipari.

† The Neapolitan *Cantara* or quintal is of two kinds; the *grasso*, or the great, and the *piccolo*, or the little. The great cantara contains 100 *rotoli*, and 3 *rotoli* make 8 pounds 4 ounces Neapolitan weight, the pound containing 12 ounces. The little cantara contains only 100 such pounds. T.

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former,

former, and six hundred of the latter. We have already mentioned the sulphur of this island, and the difficulties with which it is procured, in Chap. XIII. Sulphate of alumine still abounds here; but the extraction of it is attended with the same difficulties as that of the former mineral. These are occasioned by the numerous sulphureous fumes, and the heat, which exhale from the subterranean caverns, and which are found the strongest in the places where that salt most abounds. I am, therefore, of opinion that, at the time these substances were dug here, the state of the volcano must have been different.

The people of Lipari might, however, if I am not mistaken, derive another more stable advantage of which they have hitherto been ignorant, or have neglected, from this deserted island. This would be obtained from the productive plantations that might be made in the southern parts of the island, to which, for a great length of time, the fire has never extended its injuries. This part
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of the island consists of a softened and half-crumbled lava, similar to that of Stromboli, where vines thrive so well; nor can I discover why they should not succeed equally well in Vulcano. The same idea has occurred to Trovatini; and the bishop of Lipari, whom I have before mentioned with the respect which is due, told me that he had thoughts of attempting the cultivation of Vulcano by sowing corn and planting vines and fruit-trees.

The bishop likewise communicated to me another idea which I did not expect. He said he had conceived the design of building a seminary in that island, for the education of twelve youths, sons of the peasants, who should be brought up to the service of the cathedral, and of the parish churches of the other Eolian isles. He very justly thought that these youths, having been born and educated in the islands, would be better fitted for, and more attentive to, the discharge of such duties. Whether since the death of this

prelate any attempts have been made to carry his useful plans into execution, I cannot say. The little disposition which those who succeed to any office usually shew to complete the projects of their predecessors, inclines me to think it very doubtful whether Vulcano will not still remain in its former deserted and barren state.

IV. SALINE.

DIDYME, or, as it is at present called, le Saline (or the salt pits), is very different from Vulcano. This island in many parts has its skirts covered with cottages, and abounds in vines, the grapes of which yield wines not inferior to those of Lipari.

At a little distance from the sea, near Santa Maria, a continual spring of fresh water rises. The great heat of many such springs is usually an unequivocal sign, if not of the existence of a volcano, at least of subterranean effervescences. This, however, when I examined it by the thermometer, appeared to

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be $2\frac{1}{2}$ degrees cooler than the temperature of the atmosphere*. It formerly issued nearly on a level with the water of the sea, with which it frequently mixed, and thus became almost useless to the inhabitants ; but this inconvenience has within these few years been remedied, by a vertical section being made in the shore ; in consequence of which it now issues fifteen feet above the level of the sea. It is very abundant, and throws up five streams of water, each about an inch in diameter, which is very extraordinary in a volcanic island ; at least in any of those of Lipari.

This plentiful spring, there can be no doubt, is supplied by rain-water, as, in the present time, the opinion that fountains and rivers are immediately derived from the sea,

* I shall here observe that, excepting some places in Stromboli, Vulcano, Lipari, and a spring in Felicuda, I never could perceive, though I used the thermometer, that the Eolian isles, other circumstances being the same, are warmer than Messina, the coasts of Calabria, and other neighbouring countries which are not volcanic.

is entirely exploded. The rains, however, by which it is nourished are not to be sought in remote countries; they can only be those which fall on the island. It must at the same time be confessed, as I was assured by the natives, that there has sometimes been no rain there for nine months, and yet this spring, in all that time, did not appear to suffer the smallest diminution. In what manner then shall we account for this, if we ascribe its origin to rain-water? I can see no absurdity in the supposition, on the contrary, it appears to me extremely probable, that, in the internal parts of an island which, like this, is the work of fire, there may be immense caverns that may be filled with water by the rains, and that in some of these which are placed above the spring, the water may always continue at nearly the same height, and a long drought consequently produce no alteration in the spring. By a similar hypothesis, which does not appear to me at all forced or unnatural, we have explained above the origin of the spring which continually flows in Stromboli.

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I have already mentioned that this island received the name of Saline (salt-pits) from the muriate of soda (sea-salt) which is obtained in it. A brief account of this product, and the place where it is procured, may not be unacceptable to my readers. Close to the shore, on the south-east side of the island, there is a lake of about a mile in circuit, separated from the sea only by a bank of lava, not formed by art, but by the sea itself, which has raised it by the beating of its waves. It appears indubitable, that this lake was once a small bay or creek of the sea, which has been shut out by the accumulation of the lava, though its waters are still admitted by secret channels; since, notwithstanding the continual evaporation, the lake remains full. In consequence of this continual evaporation, however, the water in it becomes saltier than that of the sea, and in consequence forms a crust of muriate of soda (sea-salt) on its banks. The lake has every appearance of being very ancient, but had been long neglected; until in the year 1750 an attempt was made to
render

render it more advantageous, under the direction of a native of Trapani, who was acquainted with the nature of salt-works. He first drained the lake, and then dividing it into thirty square pits, each separated by high banks, let in the sea-water to a certain height, which gradually evaporating by the heat of the sun, which in summer is there very great, left on the sides of the banks and at the bottom a stratum of salt. This method has been continued since, and the salt collected twice or thrice every year, according as the heat of the season more or less favours the evaporation. The quantity procured is sufficient to supply all the Lipari islands.

The inhabitants from whom I received this account related to me at the same time a fact that excited my surprise. The sea in a violent storm making its way into the lake, carried with it a number of fish of the *cephalus* or chub species, which continued to live in the lake as in their native element. They multiplied very fast, notwithstanding the

the water by a new evaporation was rendered extremely salt ; and when they were afterwards taken out, they were found to be very fat and well-flavoured. This the more surprised me, because some years before, in another part of the Mediterranean, that is where the river Magra falls into the sea, near Carrara, I had observed this species of fish delight in water almost fresh ; leaving the open sea for the mouth of the river, and appearing to seek those places in which the sea-water, mixed with that of the river, had less saltiness ; to which places the fishermen resorted to catch them. Other species of sea-fish without number are of a very different nature, not being able to live in water which is saltier than that of the sea. Thus near Chiozza, in the Venetian state, I have found some which presently died when put in water saturated with muriate of soda (sea-salt), nearly the same with that of the lake above mentioned, and prepared for the same use. Such a difference of temperament in animals formed to inhabit the sea must doubtless be the result of a difference of organization,

ganization, though we are ignorant in what it consists, less perhaps from the difficulty of discovering it, than from our not having directed our enquiries towards this part of the animal economy.

V. VI. FELICUDA AND ALICUDA.

THESE two islands are the last of those of Lipari towards the west. In Felicuda the houses are scattered over the whole island, which contains about six hundred and fifty inhabitants; but in Alicuda, the population of which is not so great, they are built only at the south and south-east end of the island; it being in fact impossible to build them any where else, the rest of the island consisting only of cliffs, and crags, steep precipices and inaccessible rocks. It is observable that these houses, or rather cottages, are not erected at the shore, or base, of these mountainous islands, but about half way up on the side which has a very steep declivity, where likewise stand the houses of the two parish priests. I at first was unable to conceive

why a situation so difficult to reach from the steepness of the ascent, had been preferred for their houses to the lower part of the islands, which is much less steep and nearly level with the sea. But I was told by both the peasants and the priests, that this situation had been chosen by their ancestors because that formerly Felicuda and Alicuda, being the most remote from the principal island, were greatly exposed to the attacks of the Turks, especially the Tunisian corsairs, who frequently landed there in the night, surprised the islanders while asleep in their houses near the shore, plundered them of their goods, and carried them away into slavery, as they have sometimes made similar predatory descents, in the present times, on the coast near Genoa. The people of Alicuda and Felicuda on this account built their houses where the danger was less. The Eolian islands are indeed still liable to such visits from their African neighbours. It is true the latter do not always succeed in their design, but sometimes pay dearly for their temerity; yet it is necessary for

the

the islanders to take every precaution, on which account there is a sentinel stationed on the Monte della Guardia at Lipari, who is on the watch night and day. This, however, does not deter the barbarians from frequently stretching over to those islands; where they lie in wait under a rock, a cape, or a point of land, till they see some small vessels, when they dart like vultures on their prey incapable of resisting their force, and setting their sails, if the wind be favourable, or labouring with their oars, are soon out of sight of the islands and in the open sea; where it little avails the unhappy wretches they have made slaves to lament their fate or sue for mercy. I will confess that, frequently, while making the circuit of these islands, I was not without my fears that I might in this manner be carried to make observations of a very different kind on the neighbouring coasts of Africa.

Besides Indian figs and some olive-trees, these two islands contain many vines, from the grape of which a good wine is made, though

though it is not malmsey, nor the grape the passola or passolina.

The corn grown here is barley and wheat; of which, together with the grapes, there is produced in Alicuda to the value of about three thousand Neapolitan crowns; and about one-third more in Felicuda. This quantity of corn is sufficient for the support of Alicuda; but the produce of Felicuda is not sufficient for it; the Liparese, who are owners of a number of the small farms there, carrying away a considerable quantity.

The industry and patience of the people of Alicuda is incredible: they do not lose an inch of the ground they cultivate. There is scarcely a tract of cultivable land of a few perches in circuit, which is not interrupted with points of rocks, masses of lava, clefts, and crags: yet all these tracts they render productive: they turn and break them with pointed spades, and render every foot of them fruitful; on which account the Liparese say, jestingly, that the people of Alicuda

cuda till their lands with the point of a knife. It is certain, at the same time, that in all the Eolian isles there is no better bread than that made in Alicuda. I have tasted it, and can affirm that it is most excellent.

Few fish are taken in these islands, because there are but few fishermen, and these have no nets, but only use the hook and line. The whole number of boats, likewise, either used for fishing, or to pass from one island to the other, is only five or six in Felicuda, and three or four in Alicuda. When they no longer want to use them, they draw them up out of the water on the dry beach, where the sea cannot reach them, till they again have occasion for them. One or two of these boats usually belong to the parish-priest, who not only makes use of them in fishing, but for other purposes; as to go to market to Lipari, or to accommodate a stranger, in which case he will not refuse to act as pilot, or, on an emergency, as rower. Necessity, the mother of industry, impels these good
priests

priests to endeavour to find employment, as they could scarcely live, however wretchedly, one half the year, on their ecclesiastical revenues, which amount to little more than twelve sequins, annually, for each island.

At Felicuda, when the husband or wife died, it was a custom considered as a kind of sacred duty for the nearest relations to follow the body to the grave with loud and immoderate lamentations, and, as soon as the obsequies were finished, to throw themselves upon the corpse, embrace it, kiss it, speak to it with a loud voice, and give commissions for the other world. This ridiculous practice, which is not modern, has been abolished by the present priest.

In neither of these islands is there a single spring of fresh-water. The inhabitants are therefore obliged to have recourse to the rain-water they can preserve in cisterns; and, when it happens not to rain for several months, their distress is extreme.

The people of Alicuda and Felicuda, in fact, of all the Eolian isles, boast that their islands are exempt from every kind of serpents; and, indeed, in all my excursions in them, I never met with one. The reason of this evidently is because the food necessary for these creatures is wanting: they feed principally on insects and other small animals, of which I found here very few. The scarcity of these latter is likewise to be accounted for on the same principle; as it is known that they feed on vegetables chiefly of the herbaceous kind, which, in these islands, are extremely rare.

Of other animals of the amphibious kind I only met with the gray and green lizard (*Lacerta agilis* Lin.), and, with respect to insects, only some grasshoppers, and the lion-ant (*Myrmeleon formicarius* Lin.) which are found in great numbers among the dust of the pumices and lavas.

The people of these islands may likewise boast of an advantage incomparably more important;

important ; I mean, that their sovereign, in consideration of their poverty, has exempted them from every kind of taxation, only paying tythes to the bishop, from which, however, the people of Lipari are exempted.

It is incredible, at the same time, how contented these islanders are amid all their poverty. Ulysses, perhaps, cherished not a greater love for his Ithaca, than they bear to their Eolian rocks, which, wretched as they may appear, they would not exchange for the Fortunate Islands. Frequently have I entered their huts, which seem like the nests of birds hung to the cliffs. They are framed of pieces of lava ill joined together, equally destitute of ornament within and without, and scarcely admit a feeble uncertain light, like some gloomy caves. Sometimes I have been present at their wretched meals, set out in coarse dishes, or on the bare ground on which they sat, and consisting of black barley bread, and wild fruits, and, sometimes, by way of dainty,

some salt-fish, and pure water to quench their thirst. Attending only to the first impression of the scene, I thought I beheld the perfect image of wretchedness and misery: but, on more mature consideration, I discovered in these rude huts, and in the midst of this hard fare, an enviable happiness, which, I doubt, is not to be found in the palaces of the great, or among the delicious viands of royal tables. A cheerfulness and perfect tranquillity shone in the countenances of these poor people, and evidently possessed their hearts. Their ruinous cottages, which must be viewed with pity and contempt by the rich and great, to them were dear; and the food, which the luxurious would have rejected as insipid or nauseous, to their palates had an exquisite flavour. But the frugal meals of these islanders are always seasoned with a sauce which never accompanies the dishes at the tables of the great, I mean hunger and thirst, which render every meat delicious and every beverage grateful. The labour of their hands and the sweat of their brow

secure

secure an exquisite relish for their scanty fare.

As to the content and tranquillity of these islanders, and the affection they bear their native country, I do not think I should greatly err, were I to ascribe it to the happy temperature of the climate, and the quality of the air, which, when pure, so much contributes to maintain in us the proper harmony between the solids and the fluids, or the state of perfect health. A proof of this I experienced in myself. Notwithstanding the continual and great fatigues I underwent in my excursions among those rocks, and notwithstanding my advanced age, I felt in myself an energy and vigour of body, an agility and liveliness of mind, and a certain animation of my whole frame, which I had experienced no where else, except on the summit of mount Etna. In countries infested with impure air and thick vapours, I have never been able to apply myself to my favourite studies immediately after dinner; but, under this sky, which is so rarely

overclouded with vapours, I could write on the spot, at any time, a part of those observations I am now about to present to the public. How immense the difference between this most pure and almost celestial air, and the fœtid and foggy atmosphere of some of the low plains of Lombardy, surrounded by stagnant and filthy waters and unhealthy rice-grounds, producing continual clouds and fogs in winter, and obstinate fevers in summer; where the spirits are depressed, and rendered dull; and where, to complete the catalogue of ills and inconveniences, innumerable hosts of frogs, in the warm season, both by night and day, deafen the ear with their incessant croakings!

CHAP. XXV.

STATE IN WHICH THE AUTHOR FOUND
MESSINA AFTER THE EARTHQUAKE
IN 1783—ACCOUNT OF THE CALA-
MITOUS ACCIDENTS WHICH BEFEL
THAT UNFORTUNATE CITY.

*Great numbers of the people of Scilla drowned
by the waves of the sea—A long range
of palaces adjoining to the harbour, almost
all destroyed—Prodigious number of edi-
fices within the city either thrown down,
or on the point of falling—Wooden sheds
erected by the people of Messina to lodge in
till the houses could be rebuilt—Injurious
effects produced by fear which had seized
entirely on the minds of the inhabitants—
Account of the different dreadful shocks
which laid waste the city, and the circum-
stances by which they were preceded and
accompanied—Other shocks followed, but*

successively weaker—The buildings of which the foundation was granite least damaged—The mole, which was constructed in ground not sufficiently solid, entirely carried away and buried in the sea—Enumeration of the more considerable edifices which were reduced to ruins—Incalculable losses sustained by the destruction of the monuments of the arts, and the property buried under the ruins, or consumed by the fires which broke out after the earthquake in different parts of the city—Exertions of the King of the Two Sicilies to restore Messina to its former flourishing state.

IN the forenoon of the 14th of October, I left the Eolian isles, and sailed from Lipari, in a felucca, for Messina, which is distant from that island thirty miles, but where I did not arrive till the middle of the next day; partly from having stopped some time to make observations on the granites of Melazzo, and from the want of wind, which obliged the mariners to have recourse to their oars. With these islands I was to dis-

miss every idea of volcanos either still burning or extinct, as that part of Sicily to which I was approaching exhibited not the least trace of that nature. I do not mean to say that at different times it may not have suffered by their destructive effects, if it be true, as I believe it to be, that partial earthquakes, that is, those which are felt through a not very extensive tract of country, and at a small distance from a volcano, originate either mediately or immediately from that volcano. In fact, what island has suffered more in this manner than Sicily, and that from nourishing within its bosom the Etnean conflagrations? When I travelled in those parts, the dreadful effects of the earthquake of 1783 were the common subject of discourse. On my entering, in the felucca, the Strait of Messina, some of the people who were with me pointed out to me the shore of Scilla where a great number of people were drowned at that calamitous time. A dreadful shock of an earthquake took place, about noon, on the 5th of February of the above year, which terrifying

fyng the people of Scilla, they fled in crowds to the shore, when, about eight o'clock the following night, according to the Italian reckoning *, another violent shock succeeded, in which the waves rose so high that they covered the whole shore, and out of more than a thousand persons who were there collected, among whom was the Prince of Scilla himself, not one escaped to relate and mourn the fate of the rest. The furious waves, rushing into the strait, penetrated to the harbour of Messina, and nearly sunk the vessels there at anchor.

When I arrived opposite to the city, I began to see the fatal and ruinous effects of this dreadful earthquake. The curvature of the harbour was formerly embellished, for the extent of more than a mile, with a continued range of superb palaces, three stories in height, usually called the *Palazzata*, inhabited by merchants and other persons of opulence, which formed a kind

* About one in the morning.

of superb amphitheatre. The upper story, and a part of the second, of these buildings were entirely thrown down, the lower greatly torn and damaged, and the whole of this extensive pile deserted by its inhabitants.

When I entered the city, every object which met my view tended to awaken melancholy sentiments and commiseration. Excepting some of the wider and more frequented streets, the rest were all heaps of ruins, either piled up on each side, or scattered in the middle, and rendering it impossible to pass them. Many of the houses were still in the same ruinous state in which they had been left by the earthquake; some entirely destroyed and levelled with the ground, others half thrown down, and others still standing, or rather hanging in the air, merely from the support afforded by the ruins around them. Those which had escaped this destruction appeared as if preserved by a miracle, torn and rent as they were. The cathedral was among the number of these fortunate edifices. This is a spacious

spacious building, of gothic architecture. Its interior has suffered little or no damage. It is embellished with a number of columns of granite brought from an ancient Grecian temple, which once stood on the Faro (or Strait of Messina), and with elegant Mosaic work wrought with the most beautiful jaspers of Sicily.

The destruction of so great a number of houses as were thrown down by this dreadful earthquake obliged the people of Messina to take refuge in wooden sheds built for the occasion, many of which were still standing when I was there. They had begun, however, to rebuild the houses, but on a different plan from the old ones. They had observed that the highest had suffered most, and that, in the violent shocks of the earthquake, the beams, by continually and forcibly beating against the walls, had completed the ruin of the edifice. They therefore resolved to build them lower, and to construct the wood-work in such a manner, that, in case of a similar visitation, the
shock

shock should be sustained by the whole of the building, and not by a part only. This precaution, it is evident, must be of the greatest utility, should the city again suffer a calamity of this nature.

Though it was now nearly the sixth year since that dreadful disaster, considerable remains of the dread, consternation, and, I may say, stupefaction, which usually accompany great terrors were still manifest in the minds of the people of Messina. They had still present in their memory all the circumstances of that dreadful time; nor could I listen to the narrative they gave of them without shuddering.

That ancient city, which had so repeatedly suffered, was not destroyed by one but several earthquakes, which lasted in successive shocks, from the 5th to the 7th of February 1783. The most destructive was that of the 5th, but an interval of some minutes elapsing between the first and second shock, the inhabitants had time to quit

quit their houses, and fly to the open plain. Hence the number of those who were killed was not proportionate to the quantity of ruins. They did not exceed eight hundred.

In a memoir relative to the earthquakes in that part of Calabria opposite to Messina, which happened at the same time, it is said that, before the first shock, the dogs in the city began to howl violently, and were killed by a public order. On my enquiring of the people of the country, they assured me that the fact was false, and that no other phenomenon preceded this calamity but the flight of the sea-mews and some other birds from the sea to the mountains, as they usually do on the approach of a tempest. A very violent noise, resembling that of a number of carriages rattling over a stone-bridge, was the first symptom, while at the same time a thick cloud arose from Calabria, which was the centre of the earthquake, the propagation of which was successively apparent by the fall of buildings from the point of the Faro to the city of Messina, as if at that point a
mine

mine had been fired which extended along the shore and continued into the city. The shock was most violent, and the motion extremely irregular. In no part were any fire or sparks observed. The ground along the shore opened in fissures parallel to it; and though in some places these continued more than a month, the dread and consternation with which every one was seized, prevented any attempt to measure them.

After the first shock, which, as we have said, took place about noon, on the 5th of February, the earth continued incessantly to tremble, sometimes with a slighter and sometimes a more violent motion; till at eight the following night another tremendous shock, which was fatal to the people of Scilla, completed the destruction of the remainder of the fabrics of Messina. The earthquakes did not cease till the 7th, when another dreadful shock spent its rage upon the ruins.

From that time till my arrival at Messina,

shocks have continued to be felt, but gradually diminishing in force and number; and in 1789 and 1790, only four or five were observed, and those so extremely feeble, that, in any other country less affected by fear and alarm, they might not have been noticed, or not supposed to be earthquakes*.

The loss was immense, and is difficult to calculate. Considering the buildings alone, it may be asserted without hesitation, that, dividing

* In the following years, however, earthquakes again renewed the terrors of the people. The following is the extract of a letter from the Abbate Grano to me, of the 11th of May, 1792:

“Yesterday we had a whole day, as I may say, full of earthquakes. I counted as many as thirty shocks, but all slight, and which occasioned no damage.”

I embrace with the utmost pleasure this opportunity of thus publicly expressing my gratitude to and doing justice to the merits of this my illustrious friend, the Messinese nobleman abovementioned, and whom I shall again have occasion to cite.

As he is versed in the studies of philosophy and natural history, he had the goodness to accompany me in my excursions in different parts of his country, and his scientific

dividing them into four parts, two were levelled with the ground; the third half laid in ruins, and the fourth greatly damaged. Among the latter were the houses situated on the declivity of the hills, which have for their foundation granite, as we shall notice again in another place (Chap. XXIX). Those which were most completely ruined, and likewise the first to fall, were such as stood in the plain, and especially on the curvature of the harbour, on a ground less solid, as it had been formed by the washing and depositions of the sea. The mole of the harbour, which extended more than a mile in length, and was resorted to for the beauty of the pro-

scientific assistance was of the greatest advantage to me. This assistance he not only afforded me when present, but even when absent, furnishing me with various local notices which might render my accounts relative to those countries more interesting; and his industry and circumspection in the examination of nature, and his sincere love of the investigation of truth, leave no doubt of the accuracy of his observations.

spect, was entirely swallowed up by the sea, so that no vestige of it remained to point out where it once was.

Among the ruined edifices the most considerable were the abovementioned *Palazzata*, called likewise the maritime theatre; the royal palace; the palace of the senate, of noble architecture; the exchange of the merchants; the celebrated college, with the temple annexed; the church and professional-house of the ex-jesuits; the archbishop's palace, with the basilica of San. Niccolo; the seminary of the clergy, the hall of the tribunals, the church of the annunciation of the Theatines; that of the Carmelites, and of the priory of the Hierosolymitans, with several other fabrics both sacred and profane; without mentioning the palaces of the nobles and opulent citizens, all of an elegant architecture.

It is impossible to estimate the loss suffered by the destruction of the numerous monuments of the arts, libraries, and galleries of pictures,

pictures, with which Messina was embellished; where the imitative arts had long flourished.

Equally impossible is it to calculate the loss sustained by the valuable effects that were buried beneath the ruins, or burned in the fires which after the earthquake broke out in various parts of the city. We must also add the expence of building the wooden sheds and huts necessary to shelter the inhabitants, and for the reception of such moveables or commodities as had been saved from the ruins; which expence was extremely great from the high price to which all the materials for building immediately rose, and the great wages required by workmen of every kind.

Yet, notwithstanding all these losses and expences, which must greatly have impoverished the country, not a single merchant became a bankrupt; a circumstance which redounds highly to the honour of Messina, as it is certain that no event can happen

which furnishes a more plausible excuse to the fraudulent dealer than an earthquake.

The King of the Two Sicilies has omitted no means that may contribute to the restoration of Messina. He has exempted it from all public imposts, given considerable sums from his own purse, granted a free port, jurisdiction of magistrates, &c. Yet the immense losses the city has suffered, notwithstanding every assistance, cannot be repaired under a great length of time.

The buildings have since been considerably increased and improved, so that more than one half of the city is now rebuilt, and the people have left the sheds and taken possession of the new houses.

It appeared to me that this concise relation of the late dreadful earthquakes at Messina, and their consequences, would be acceptable to the curious and learned reader. We will now proceed to the description of other objects deserving attention in this celebrated strait and its mountainous environs.

C H A P. XXVI.

OBSERVATIONS ON SCYLLA AND CHARYBDIS.

A kind of confused noise, like the barking of dogs, heard on approaching the rock of Scylla, produced by the dashing of the waves of the sea—Images highly resembling nature exhibited by Homer and Virgil in their personifications of Scylla—The appearance of this rock the same at present as in the time of the Greek poet—The sea there of the same height as formerly—Great danger of dashing on the rock of Scylla when the current runs from south to north, and an impetuous south wind blows at the same time—Mariners at Messina, whose business it is to assist vessels in danger—Ships easily wrecked without this assistance, though those who steer them should be very expert seamen—Tempest ob-

served by the author in the Strait of Messina, and the courage with which these Messinese sailors brought a vessel in distress safely into the harbour—Precise situation of Charybdis—Until the present time considered as a true whirlpool—The fragments of ships swallowed up in it carried, as some have believed, thirty miles—Anecdote relative to this opinion—Phenomena of the current of the Strait, which ascends and descends by intervals—Visit of the author to Charybdis—Its appearance as first seen from the shore—Observations made on a nearer approach, and on entering it in a boat—Charybdis not properly a whirlpool, but an incessant motion of agitated waters, which ascend, descend, dash and rebound—Consequences which followed on throwing certain bodies into it—No gulph below Charybdis—Depth of the sea much less there than in the middle of the Strait—Charybdis cannot even be called a whirlpool in tempestuous weather—Cause of the loss of ships that are drawn into it—Recent shipwreck which happened in it without any appear-

ance of a whirlpool—Origin of this error—None of the numerous writers who have mentioned Charybdis, say that they had visited and examined it—Charybdis twelve miles distant from Scylla, though Homer styles it very near—Improbable that any such change can have taken place in the Strait of Messina, as to have removed Charybdis so far from Scylla—Change that has happened in the present age, much posterior to the date of the accounts of a number of writers who place Charybdis in the situation where it is now found—Truth and physical explanation of the proverb, that “he who endeavours to shun Charybdis dashes upon Scylla”—Scylla and Charybdis, according to the ancients, dangerous from frequent tempests and shipwrecks—Very different in the present times—Enquiry into the cause of this difference—It probably is to be ascribed to the improvements made in the art of navigation—Examples in proof of this afforded by the Adriatic and the Cape of Good Hope.

SCYLLA and **Charybdis**, according to the fables of the poets, are two sea-monsters whose dreadful jaws are continually distended to swallow unhappy mariners; the one situated on the right, and the other on the left extremity of the Strait of Messina, where Sicily fronts Italy.



Dextrum Scylla latus, lævum implacata Charybdis
Obsidet, atque imo barathri ter gurgite vastos
Sorbet in abruptum fluctus, rursusque sub auras
Erigit alternos, et sidera verberat unda.

At Scyllam cæcis cohibet spelunca latebris
Ora exertantem, et naves in saxa trahentem.
Prima hominis facies et pulchro pectore virgo
Pube tenus; postrema immani corpore pristis
Delphinum caudas utero commissa luporum.

VIRG. ÆNEID. lib. iii.

Far on the right her dogs foul Scylla hides;
Charybdis roaring on the left presides,
And in her greedy whirlpool sucks the tides.
Then spouts them from below; with fury driv'n,
The waves mount up and wash the face of heav'n.
But Scylla from her den, with open jaws,
The sinking vessel in her eddy draws,
Then dashes on the rocks: a human face,
And virgin bosom, hide her tail's disgrace;

Her

Her parts obscene below the waves descend,
With dogs inclos'd, and in a dolphin end.

DRYDEN.

I have no difficulty in availing myself of the description of a poet in a work dedicated to the investigation of truth; nor shall I hesitate to cite similar passages from another poet; since, however exaggerated these may be by the glowing colours of imagination, they contain truth, and afford a subject for interesting enquiries.

I should have thought myself to have merited the greatest censure, if, when I was in the Strait of Messina, I had not visited two places of which so much has been written, and which have been rendered so famous by the numerous shipwrecks they have occasioned.

I first proceeded in a small boat to Scylla. This is a lofty rock, distant twelve miles from Messina, which rises almost perpendicularly from the sea, on the shore of Calabria, and beyond which is the small city of
the

the same name. Though there was scarcely any wind, I began to hear, two miles before I came to the rock, a murmur and noise, like a confused barking of dogs, and on a nearer approach readily discovered the cause. This rock in its lower part contains a number of caverns; one of the largest of which is called by the people there *Dragara*. The waves, when in the least agitated, rushing into these caverns, break, dash, throw up frothy bubbles, and thus occasion these various and multiplied sounds. I then perceived with how much truth and resemblance of nature Homer and Virgil, in their personifications of Scylla, had pourtrayed this scene, by describing the monster they drew as lurking in the darkness of a vast cavern, surrounded by ravenous, barking, mastiffs, together with wolves to increase the horror.

Ἐνθα δ' ἐν Σκυλλῇ ναιεὶ δεινὸν λελακνῖα
 Τῆς ἥτοι φωνῇ μὲν ὅση σκυλακὸς νεογίλης
 Ἰνέσται.

HOM. ODYSSEY. XII.

Here Scylla bellows from her dire abodes,
 Tremendous pest! abhor'd by man and gods!

Hideous

Hideous her voice, and with less terrors roar
The whelps of lions in the midnight hour!

POPE.

The Greek Poet, when he pourtrays the rock which is the habitation of Scylla, finishes the picture higher than the Latin, by representing it as so lofty that its summit is continually wrapped in the clouds; and so steep, smooth, and slippery, that no mortal could ascend it, though he had twenty hands and twenty feet.

Ἄοι δὲ δυν σκοπελοῖ, ὁ μὲν οὐρανὸν εὐρὺν ἱκανεῖ

Ὅξεϊν κορυφῇ νεφέλῃ δὲ μιν ἀμφίβεβηκε

Κυανὴν τὸ μὲν οὐπὸτ' ἔρπει οὐδεπὸτ' αἰδρῇ

Κεῖνου ἔχει κορυφὴν, οὐτ' ἐν θέρει, οὐτ' ἐν ὀπῶρῃ

Οὐδὲ μὲν ἀμβλῆν βροτὸς ἀνὴρ οὐ καλὰ βάλει

Οὐδ' εἰ οἱ χεῖρες γέ εἰκοσι, καὶ ποδὲς ἦεν

Πῆρῃ γὰρ λῖς ἐστὶ περιβέβη εἰκὺς.

HOM. OD. XII.

High in the air the rock its summit throws
In brooding tempests and in rolling clouds;
Loud storms around, and mists eternal rise,
Beat its bleak brow, and intercept the skies.
When all the broad expansion bright with day
Glow with th' autumnal or the summer ray:
The summer and the autumn glow in vain;
The sky for ever low'rs, for ever clouds remain.

Impervious

Impervious to the step of man it stands;
 Though borne by twenty feet, though arm'd with
 twenty hands.

Smooth as the polish of the mirror rise
 The slippery sides, and shoot into the skies.

POPE.

Such, three thousand years ago, or nearly so, appeared the rock of Scylla, according to the observations of Homer; and such is nearly its appearance at this day.

The accuracy of this truly "first great painter of antiquity," which has likewise been observed by scientific travellers in other descriptions which he has given, shews that the level of the waters of the sea was at that time at nearly the same height as at present, since, had it sunk only a few fathom, it must have left the foot of the rock, which according to my observations is not very deep, entirely dry. And this I consider as one among several strong arguments, that the most remarkable sinkings of the sea are anterior to the time of Homer.

Such is the situation and appearance of
 Scylla:

Scylla : let us now consider the danger it occasions to mariners. Though the tide is almost imperceptible in the open parts of the Mediterranean, it is very strong in the Strait of Messina, in consequence of the narrowness of the channel, and is regulated, as in other places, by the periodical elevations and depressions of the water. Where the flow or current is accompanied by a wind blowing the same way, vessels have nothing to fear; since they either do not enter the Strait, both the wind and the stream opposing them, but cast anchor at the entrance; or, if both are favourable, enter on full sail, and pass through with such rapidity that they seem to fly over the water. But when the current runs from south to north, and the north wind blows hard at the same time, the ship which expected easily to pass the Strait with the wind in its stern, on its entering the channel is resisted by the opposite current, and, impelled by two forces in contrary directions, is at length dashed on the rock of Scylla, or driven on the neighbouring sands; unless the pilot shall apply for
the

the succour necessary for his preservation. For, to give assistance in case of such accidents, four-and-twenty of the strongest, boldest, and most experienced sailors, well acquainted with the place, are stationed night and day along the shore of Messina; who, at the report of guns fired as signals of distress from any vessel, hasten to its assistance, and tow it with one of their light boats. The current, where it is strongest, does not extend over the whole Strait, but winds through it in intricate meanders, with the course of which these men are perfectly acquainted, and are thus able to guide the ship in such a manner as to avoid it. Should the pilot, however, confiding in his own skill, contemn or neglect this assistance, however great his ability or experience, he would run the most imminent risk of being shipwrecked. In this agitation and conflict of the waters, forced one way by the current, and driven in a contrary direction by the wind, it is useless to throw the line to discover the depth of the bottom; the violence of the current frequently carrying the lead almost
on

on the surface of the water. The strongest cables, though some feet in circumference, break like small cords. Should two or three anchors be thrown out, the bottom is so rocky, that they either take no hold, or, if they should, are soon loosened by the violence of the waves. Every expedient afforded by the art of navigation, though it might succeed in saving a ship in other parts of the Mediterranean, or even the tremendous ocean, is useless here. The only means of avoiding being dashed against the rocks, or driven upon the sands, in the midst of this furious contest of the winds and waves, is to have recourse to the skill and courage of these Messinese seamen.

In proof of the truth of this assertion, I might adduce many instances related to me by persons deserving of credit. But I was myself an eye-witness to the situation of a trading vessel from Marseilles, which had one day entered the Strait by the mouth on the north side, at the time that I was on a hill looking towards the sea. The current,
and

and a north wind, which then blew strong, being both in its favour, the vessel proceeded under full sail into, and had passed one half of, the Strait, when, on a sudden, the sky became overcast with thick clouds, and violent gusts of wind arose, which in an instant changed the direction of the current, and turned up the sea from its bottom. The mariners had scarcely time to hand the sails, while the furious waves broke over the ship on every side. Whether they merely followed the practice usual with ships in distress, or whether they were acquainted with the laudable custom of the Messinese, I cannot say; but they fired two guns: immediately upon which one of the barks employed on this service hastened to the assistance of the distressed vessel, and, taking it in tow, began to make every exertion to carry it safely into the harbour.

If I had seen with fear and shuddering the danger of the sailors on board the vessel, which I expected every moment would be swallowed up in the waves; I beheld with wonder

wonder and pleasure the address and bravery of the Messinese mariners, who had undertaken to steer safely through so stormy a sea the ship entrusted to their care. They extricated it from the current which impelled it towards destruction; changed the helm to this side or to that; reefed or let out the sails, as the wind increased or abated; avoided the impetuous shocks of the waves by meeting them with the prow, or opposing to them the side, as either method appeared most proper to break their violence; and by these and other manœuvres which I am unable to describe, these brave mariners, amid this dreadful conflict of the sea and the winds, succeeded in their undertaking, and brought the vessel safe into the harbour.

But enough of Scylla:—we will now proceed to Charybdis. This is situated within the Strait, in that part of the sea which lies between a projection of land named *Punta Secca*, and another projection on which stands the tower called *Lanterna*, or the light-house, a light being placed at

its top to guide vessels which may enter the harbour by night.

On consulting the authors who have written of Charybdis, we find that they all supposed it to be a whirlpool. The first who has asserted this is Homer, who has represented Charybdis as a monster which three times in a day drinks up the water, and three times vomits it forth.

— δια Χάρυβδὸς ἀναρροῖσθαι μέλαν ὕδωρ,
 Τρεῖς μὲν γὰρ τ' ἀνιησὶν ἐπ' ἡμᾶσι, τρεῖς δ' ἀναρροῖσθαι
 Δεινόν.
 HOM. ODYS. XII.

Beneath Charybdis holds her boisterous reign
 Midst roaring whirlpools, and absorbs the main;
 Thrice in her gulphs the boiling seas subside,
 Thrice in dire thunders she refunds the tide.

POPE.

The description of Virgil, above cited, differs from that of Homer only in placing a deep gulph below. Strabo, Isidorus, Tzetzes, Hesychius, Didymus, Eustathius, &c. repeat the same. The Count de Buffon adopts the idea of Homer in full confidence, and places Charybdis among the most celebrated

brated whirlpools of the sea. "Charybdis, "in the Strait of Messina, absorbs and re-jects the water three times in twenty-four "hours*." Strabo tells us, that the fragments of ships swallowed up in this whirlpool are carried by the current to the shore of Tauromenium (the present Taormina) thirty miles distant from Charybdis†. In confirmation of this tradition, an amusing though tragical anecdote is related of one Colas, a Messinean diver, who, from being able to remain a long time under the water, had acquired the surname of *Pesce* (the fish). It is reported that Frederic King of Sicily, coming to Messina purposely to see him, made trial of his abilities with a cruel kind of liberality, by throwing a golden cup into Charybdis, which, if he brought it up, was to be the reward of his resolution and dexterity. The hardy diver, after having twice astonished the spectators by remaining under

* Buffon, Hist. Nat. tom. ii. in 12mo.

† Καταπλεθύνων δι και διαλυθέντων τα ναυαγια, παρασυρ-
ται προς νησα της Ταυρομενίας. Lib. VI.

water a prodigious length of time, when he plunged the third time appeared no more; but, some days after, his body was found on the coast near Taormina.

From the authorities here adduced, it is evident that Charybdis has hitherto been considered as a real whirlpool by both ancient and modern travellers who have given any account of it.

As I was, therefore, so near to this celebrated place, I determined to endeavour to ascertain, if possible, what it really is. It is distant from the shore of Messina about 750 feet, and is called by the people of the country *calofaro*, not from the agitation of the waves, as some have supposed, but from *καλος* and *φάρος*; i. e. *the beautiful tower*, from the light-house erected near it for the guidance of vessels. The phenomenon of the *calofaro* is observable when the current is descending; for when the current sets in from the north, the pilots call it the *descending*

*ing rema**, or current; and when it runs from the south, the *ascending rema*. The current ascends or descends at the rising or setting of the moon, and continues for six hours. In the interval between each ascent or descent there is a calm which lasts at least a quarter of an hour, but not longer than an hour. Afterwards, at the rising or setting of the moon, the current enters from the north, making various angles of incidence with the shore, and at length reaches the calofaro. This delay sometimes continues two hours. Sometimes it immediately falls into the calofaro, and then experience has taught that it is a certain token of bad weather.

As I was assured by the pilots most experienced in this practical knowledge, that

* I have observed that at Messina, as well as in other parts of Sicily, words of the Greek language, which was once that of this island, are still retained. Thus the word *rema*, derived from *ρεμμα*, a flowing or stream, is used to signify the current of this Strait.

there was no danger in visiting the calofaro, I resolved to avail myself of the opportunity. The bark in which I made the excursion was managed by four expert mariners, who, perceiving me somewhat intimidated as I approached the place, encouraged me, and assured me they would give me a very near view of the calofaro, and even carry me into it without the least danger.

When I observed Charybdis from the shore, it appeared like a group of tumultuous waters; which group, as I approached, became more extensive and more agitated. I was carried to the edge, where I stopped some time to make the requisite observations, and was then convinced, beyond the shadow of a doubt, that what I saw was by no means a vortex or whirlpool.

Hydrologists teach us that by a whirlpool in a running water we are to understand that circular course which it takes in

certain circumstances ; and that this course or revolution generates in the middle a hollow inverted cone, of a greater or less depth, the internal sides of which have a spiral motion. But I perceived nothing of this kind in the calofaro. Its revolving motion was circumscribed to a circle of at most an hundred feet in diameter, within which limits there was no incurvation of any kind nor vertiginous motion, but an incessant undulation of agitated waters, which rose, fell, beat, and dashed on each other. Yet these irregular motions were so far placid, that nothing was to be feared in passing over the spot, which I did ; though our little bark rocked very much, from the continual agitation, so that we were obliged constantly to make use of our oars to prevent its being driven out of the calofaro. I threw substances of different kinds into the stream. Such as were specifically heavier than the water, sunk and appeared no more ; those which were lighter remained on the surface, but were soon driven out of the revolving circle by the agitation of the water.

Though from these observations I was convinced that there was no gulph under the calofaro; as otherwise there would have been a whirlpool, which would have carried down into it the floating substances; I determined to sound the bottom with the plummet, and found its greatest depth did not exceed five hundred feet. I was likewise informed, to my no small surprise, that, beyond the calofaro, towards the middle of the Strait, the depth was double. I could not, therefore, but conclude from these facts, that, at that time, there was no whirlpool in Charybdis. I say *at that time*, since the case might be very different when the sea was tempestuous. I therefore made enquiry relative to this of the pilots, those, especially, who, from their tried experience, were appointed by the public to give assistance in storms to foreign vessels, and who had frequently seen Charybdis in its greatest fury. The following is the substance of the answers they gave me:—

When

When the current and the wind are contrary to each other, and both in their greatest violence, especially when the scilocco, or south wind, blows; the swelling and dashing of the waves within the calofaro is much stronger, more impetuous, and more extensive. It then contains three or four small whirlpools, or even more, according to the greatness of its extent and violence. If at this time small vessels are driven into the calofaro by the current or the wind, they are seen to whirl round, rock, and plunge; but are never drawn down into the vortex. They only sink when filled with water by the waves beating over them. When vessels of a larger size are forced into it, whatever wind they have they cannot extricate themselves; their sails are useless; and after having been for some time tossed about by the waves, if they are not assisted by the pilots of the country, who know how to bring them out of the course of the current, they are furiously driven upon the neighbouring shore of the Lanterna, where they
are

are wrecked, and the greater part of their crews perish in the waves*.

If we consider maturely these facts, we shall find that a great part of what has been written relative to Charybdis is very erroneous. We have seen how many authors, from Homer to the present time, have de-

* The following account of the shipwreck of a vessel in the calofaro was sent me, after my return from Sicily, by the Abbate Grano from Messina :

“ About three weeks ago, we were spectators of the sinking of a Neapolitan polacca in the calofaro, on its passage from Puglia, laden with corn. A most violent south-easterly wind blew, and the vessel, with all sails set, endeavoured to reach the harbour, standing off from the calofaro ; but the head of the current from the entrance by the faro took her, and drew her impetuously into it ; where, without being able to make use of her sails, she remained for some time tossed about by the waves, which, at length, either breaking over her, or opening her sides by their furious beating, sent her to the bottom. The crew, however, and a part of the cargo, were saved by the speedy assistance given by our mariners in two small barks, who had the courage to encounter the danger. You will perceive, from this, in what manner the waves may sink ships in Charybdis, without the necessity of supposing a whirlpool.”

scribed

scribed it as a real whirlpool, or great gulph revolving in itself, within the circumference of which should any ship enter it is immediately drawn to the centre and swallowed up. When the current is dying away, or when there is no current, this description has no resemblance to truth—Charybdis is then perfectly innocent, as I have been fully convinced by my own observations; and even when it is agitated and dangerous, it still contains no incavation or gulph of the nature of a vortex, but merely a strong agitation and dashing of its waves, which produces those small whirlings of its waters, which are only accidental, and not to be feared. So far likewise is Charybdis from drawing to itself and swallowing vessels, that it rather repels them and throws them to a distance.

This error has arisen like many others with respect to the productions of nature. Homer, in relating the voyage of Ulysses through the Strait of Messina, was the first who described Charybdis as an immense
vortex

vortex which absorbs and rejects the water, and the ships that approach it; exemplifying his account by the fate of some of the companions of his hero, who were carried away by the whirlpool. The writers who came after him, whether poets, orators, historians, or geographers, have followed him in this description; without any one of them taking the pains to repair to the place and examine it himself. Even Fazello the Sicilian, who was so industrious in ascertaining facts, and whose accounts of his country are so accurate, clearly shews in his description of Charybdis that he had never observed it himself; and concludes his narration with the erroneous supposition above cited, that the things swallowed up by Charybdis are conveyed by submarine currents to the shores of Taormina.

Among all who have written on this subject, we only find Cluverius who seems, at least at first view, to have visited the place. I shall transcribe his words:

“Ego

“Ego sane, cum Charybdis noscendæ gra-
 “tia aliquot dies Messanæ subsisterem, et ab
 “hominibus ejus loci, maximè vero nautis,
 “non Siculis modo, sed et Belgis, Britannis
 “et Gallis, qui hoc fretum frequentes navi-
 “gant, diligentius eam rem sciscitarer, nihil
 “omnino certi ipsis perdiscere potui, adeo
 “scilicet totum negotium omnibus obscu-
 “rum et incognitum erat. Tandem tamen
 “reperi Charybdim, quæ incolis, patriis vo-
 “cabulis, dicitur *Calofaro*, sub prædicta ad
 “Messanensem portum pharo esse mare ra-
 “pide fluens, atque in vortices actum : quod
 “non τοῖς ἐπ’ ἡμεῶν ut tradit Homerus, id
 “est *singulis diebus ter*, absorbet ingenti gur-
 “gite, revomitque aquas, sed quoties vehe-
 “mentiori fluctu fretum comitatur.”

“I remained some days at Messina, with
 “a view to obtain some information relative
 “to Charybdis ; but though I made every
 “enquiry of the people of the place, and
 “principally the sailors, not the Sicilian
 “only, but the Italian, Dutch, English and
 “French, who frequently navigate that
 “strait,

" strait, I could learn nothing satisfactory—
 " so little was known by them on the sub-
 " ject. At length, however, I found Cha-
 " rybdis, which the natives call *Calofaro*,
 " under the light-house before mentioned,
 " near the harbour, to be a sea rapidly flow-
 " ing, and forming vortices. It does not
 " absorb the waters in its vast gulph, and re-
 " ject them *thrice in a day*, as Homer tells
 " us, but as often as the sea runs high in the
 " Strait."

From the expression " I found Charyb-
 " dis" we might be induced to believe
 that he made his observations on the spot.
 It is certain, however, that he does not ex-
 plicitly tell us so : and, when treating of a
 phenomenon of which he was so anxious
 to obtain an accurate knowledge, which he
 could not procure even from the Messinese
 sailors, it is strongly to be presumed that
 he would not have suppressed a circumstance
 of that importance. As Charybdis may be
 seen from the shore, if he only went thither,
 and turned his eyes towards it, he might
 with

with truth assert he had discovered it. The other adjuncts to his account, that Charybdis is a rapid sea, and that it absorbs and rejects the water in a storm, convince me that he had not a just idea of it, but satisfied himself with the old tradition concerning Charybdis.

It may be observed that the situation of Charybdis, as it has been hitherto described, does not exactly agree with that assigned it by Homer. Let us refer to the Poet. The goddess Circe gives the following directions to Ulysses, with respect to the navigation of the Strait of Messina :

Οἱ δὲ δὺν σκοπελοῖ, ὃ μὲν οὐρανον εὐρυὴν ἵκναι

Τὸν δ' ἕτερον σκοπελον χθαμαλωτέρων ὄφει Οδυσσεύ,

Πλησίων ἀλλήλων καὶ κεν διοίστευσαι.

Τῷ δ' ἐν ἑρινεὸς ἔστι μεγάας φύλλοισι τέθληας,

Τῷ δ' ὑπο δια Χάρυβδις ἀναρροῖσθαι μέλαιν ὕδωρ.

HOM. ODYS. XII.

High o'er the main two rocks exalt their brow

Close by, a rock of less enormous height

Breaks the wild waves, and forms a dangerous freight;

Full on its crown a fig's green branches rise,

And shoot a leafy forest to the skies;

Beneath,

Beneath, Charybdis holds her boist'rous reign
Midst roaring whirlpools, and absorbs the main.

LOWE. POPE.

The first of the rocks here mentioned by Homer is Scylla, which he describes at length; and near the other, according to this poet, Charybdis is situated. The distance from one of these rocks to the other is an arrow's flight, *ἢ κεν δροίτευσεως*, which does not at all accord with the present situation of Scylla. How are we to explain this disagreement? Shall we say that Homer, availing himself of the licence in which poets are indulged, has spoken hyperbolically? I know not whether the connoisseurs in poetry will permit such a licence. Or shall we suppose that Charybdis was once much nearer to Scylla; but that in a long series of ages, it has changed its place and removed under Messina? Such a suggestion might, perhaps, be favourably received, if in remote times any considerable change had taken place in the Strait; but we know not of any; and it is not probable that a change so remarkable as the removal of
Charybdis

Charybdis from its place, would have been passed over in silence by Sicilian writers. Within the present century, it is true, this Strait, of which so much has been said, has become narrower, as we shall see in Chap. XXIX; but, at the same time, we know that, long before this event, Charybdis was situated where it is at present. The ancient and uninterrupted tradition of the Messinese respecting this fact is confirmed by the authority of the most celebrated Italian, Latin, and Greek writers—Fazello tells us, “Charybdis ex parte Siciliæ, paulo supra Messanam”—“Charybdis is situated on the side of Sicily, a little beyond Messina.”—Ovid says,

“Hinc ego dum muter, vel me Zancleæ Charybdis
Devoret!”

“Let dire Charybdis in Zanclean seas
Devour me if I change!”

And it is well known that Zancle was the ancient name of Messina, now Messina. Tzetzes in Lycophron says, Ἡ Χάρυβδις ἐπὶ

Μεσσηνίαν ἐστὶ—“Charybdis is situated near
 “Messina.”—Strabo, likewise, after having
 mentioned Messina, proceeds, Δέκνυται ἔν
 Χάρυβδις, μικρὸν πρὸς τῆς πόλεως, ἐν τῷ
 πορθμῷ—“Charybdis is seen in the Strait
 “a little before we reach the city.” Several
 other writers might be cited to the same
 purpose.

From all these reasons and historical testi-
 monies we must then conclude that Homer
 was not exact with respect to the situation
 of Charybdis; nor can it be a great offence
 to say that, in this passage of his long poem,
 he has certainly nodded. The accuracy of
 several of his descriptions of various places
 in Sicily cannot be denied. It is such that
 we must either suppose that he had himself
 travelled in those parts, as is the opinion of
 many; or, at least, that he had procured
 very faithful and circumstantial information
 from others. Of this the rocks of Scylla
 are an example. But, as to the supposed
 whirlpool of Charybdis, and its situation,
 I think

I think we may venture to affirm he never saw it himself, and that the accounts he had received of it led him into error.

We will now enquire what foundation there is for the saying which became proverbial ; that “ he who endeavours to avoid Charybdis, dashes upon Scylla ;” and which was applied by the ancients to those who, while they fought to shun one evil, fell into a worse.

On this subject I likewise made enquiries of the Messinese pilots above mentioned, and to what better masters could I apply for the elucidation of such a proverb ? They told me that this misfortune, though not always, yet frequently happens, unless proper measures are taken in time to prevent it. If a ship be extricated from the fury of Charybdis, and carried by a strong southerly wind along the Strait, towards the northern entrance, it will pass out safely ; but should it meet with a wind in a nearly opposite direction, it will become the sport of both these winds, and,

unable to advance or recede, be driven in a middle course between their two directions, that is to say, full upon the rock of Scylla, if it be not immediately assisted by the pilots. They added, that in these hurricanes a land wind frequently rises, which descends from a narrow pass in Calabria, and increases the force with which the ship is impelled towards the rock.

Before I began to write on Scylla and Charybdis, I perused the greater part of the ancient authors who have written on the subject. I observe that they almost all represent these disastrous places in the most gloomy and terrifying colours, as continually the scene of tempests and shipwrecks. These terrors and this destruction, however, they are far from exhibiting in the present times; it rarely happening that any ships are lost in this channel, either because their pilots possess the knowledge requisite for their preservation, or because they apply for the necessary assistance. Whence then arises this great difference between ancient times and the present?

present? Can we suppose that Scylla and Charybdis have changed their nature and become less dangerous? With respect to the former, we have seen that this hypothesis is contradicted by fact; Scylla still remaining such as it was in the time of Homer; and with regard to the latter, from the Strait of Messina becoming narrower, Charybdis must be at present more to be feared than formerly, as it is well known that an arm, channel, or strait of the sea is the more dangerous in proportion as it is narrow. I am rather of opinion that this difference arises from the improvement of the art of navigation, which, formerly in its infancy, dared not launch into the open sea, but only creep along the shore, as if holding it with its hand—

Alter remus aquas, alter tibi radat arenas,

Tutus eris; medio maxima turba mari.

PROPERT. lib. iii.

To shun the dangers of the ocean, sweep

The sands with one oar, and with one the deep.

But time, study and experience have

rendered her more mature, better informed, and more courageous ; so that she can now pass the widest seas, brave the most violent tempests, and laugh at the fears of her childhood.

To exemplify and support the probability of this opinion, it will not be necessary to recur to the early and rude ages ; much more modern times will furnish us with sufficient proofs. That part of the Adriatic which separates Venice from Rovigno in Istria, is certainly not the most propitious sea to navigators. The danger of being hurried in six hours from one shore to the other, and there stranded ; the frequency of violent winds which prevail there ; the shallows and sand-banks which break the waves, and render them wild and irregular ; may certainly cause some serious reflection in those who embark to make the passage. So lately as the last century, the shipwrecks in this sea were so numerous, and had so terrified the people of Rovigno, that, when any one was obliged by urgent business or any other

other cause to go to Venice, he considered himself as more likely to die than live; and, if he was the father of a family, used to make his will before he embarked. The Advocate Constantini, a native of that country, and a man of learning and ingenuity, told me when I was there, that he had read more than one of these testaments, deposited among the public archives.

But, at present, I will not say it is a diversion or pleasure to make this passage, since, as storms are not unfrequent, it is necessary to be cautious; but serious accidents rarely happen. I have myself three times made it without meeting with any cause of alarm. To what can this difference be attributed but to the improvement of the nautical art? Besides that the mariners of Rovigno were not then so expert in the management of their vessels as at present; they made use of certain barks of so improper a construction, as I was assured by the abovementioned Constantini, that it was impossible they should long resist the violence

lence of the sea. Those, on the contrary, that have been built since that time, being of a broad and flat figure, and very solid, are capable of withstanding the most furious storms. They are there called *bracere*, and are in great reputation in all the neighbouring countries. We here find a part of the sea, in which vessels were formerly so frequently wrecked, and which could not be traversed but at the risk of life, now deprived of all its terrors, and rendered easily passable, merely by the improvements made in the art of navigation.

As a farther and still more convincing proof that the dangers of Charybdis and Scylla, though in themselves the same that they anciently were, have been diminished, and the dread they inspired removed, by the rapid advances to perfection which this art has made in modern times; I shall adduce an example in another sea no less an object of terror from tempests and shipwrecks, I mean the Cape of Good Hope, called the Stormy Cape by the first discoverer, and by the mariners

mariners of those times the Raging Lion:
 How dreadful were the dangers of this place,
 where the two oceans descending down the
 opposite sides of Africa met and clashed to-
 gether ; where contending winds, whose
 power was greater in the boundless ocean ;
 where mountainous waves, rocks, and whirl-
 pools threatened inevitable destruction ! What
 preparations, what caution, were thought
 necessary for the ship which was to make
 this dangerous passage ! Able pilots who
 had frequently made the voyage ; masts and
 yards secured by additional ropes ; a large
 supply of sails and cables, thicker and strong-
 er than usual ; and a double rudder, that, in
 case one should be damaged, there might be
 another to act. The mariners were to be
 fastened to their posts by strong ropes ; the
 passengers shut down below, and the deck
 left clear for the crew ; a number of whom
 stood with hatchets in their hands, ready to
 cut away the masts should it be necessary.
 The guns were stowed in the hold as bal-
 last, and the port-holes, windows, and every
 kind of aperture, carefully closed. Such
 were

were the precautions taken in the last century on doubling the Cape of Good Hope; but how few of them are now necessary to perform this voyage in perfect safety! Of this I have had the satisfaction to be certified by an English gentleman, Mr. Macpherson, with whom I had the pleasure of conversing, in Pavia, in July 1790, and who had twice doubled this Cape in his voyages to India; a gentleman of great respectability for his information, for the various long voyages he has made, and the honourable employments he has held.

The facility with which this passage may now be made, is therefore the consequence of the perfection to which the art of navigation has arrived; and the same we may conclude with respect to Charybdis and Scylla, which, at present, have nothing terrible but the name, to those who pass them with the requisite precautions.

CHAP. XXVII.

PHOSPHORESCENT MEDUSÆ OBSERVED
IN THE STRAIT OF MESSINA.

Origin of this name, as also of those of sea-jellies or sea-nettles—Very few authors have written concerning them, and none attempted their complete history—The sketch given by Læfingius more proper to excite than gratify curiosity—Great scarcity of phosphorescent medusæ compared with those not phosphorescent—A great number of them accidentally met with by the author in the Strait of Messina—Their organization and manner of swimming in the sea necessary to be known to understand their phosphorescence—The form of their body similar to the umbella, or top, of a fungus, convex on the upper part, and concave in the under—Furnished with twelve tentacula or feelers

6

—The

—The umbella of these medusæ thicker in the upper part—Aperture and cavity in the upper part of the umbella, which probably is the mouth and stomach of these animals—Extreme simplicity of this umbella—Parts in this cavity resembling intestines and tracheæ—Fine muscular membrane in the lower internal parts of the umbella—The tentacula or feelers described—No appearance of the circulation of the humours in these medusæ—They dissolve almost entirely into a salt liquor, the salt of which is found to be muriate of soda (sea-salt)—Sea-water forms the greater part of the substance of these animals—Proofs of organization even in those parts of the medusæ in which it is not apparent—The systole and diastole in the umbella of the medusæ the cause of their progressive motion in the sea—Without this alternate action they would sink to the bottom—The seat of their systole and diastole exclusively in the fine muscular membrane above mentioned—These motions not diminished by taking the medusa out of the water; but cease when the

the muscular membrane is dried or corrupts
—Not absolutely ascertained by facts, whe-
ther the systole and diastole be independent
of the will of the animal—Particular mo-
tions in the parts resembling intestines and
tracheæ in the cavity of the umbella—Con-
jecture that the former are real intestines—
The phosphorescence of the medusæ and its
phenomena observed by night in the sea,
and in vessels filled with sea-water—This
greatest during the systole, somewhat less in
the diastole, and least in the intervals of
rest—Does not entirely cease till the medusa
is dead, and putrefaction commences—Me-
thods which will render a very small de-
gree of it sensible—The same phenomena
observable in dead medusæ left in the dry—
Medusæ which are dead, almost entirely
dissolved into a liquor, and which no longer
shine; if they are immersed in fresh water,
immediately become lucid, communicating
their resplendence to the water—The same
appearance not observable if sea-water
be used——Rain falling on medusæ
which are no longer phosphorescent, re-
stores their luminous appearance, which
cannot

cannot be effected by sprinkling them with sea-water, in imitation of rain—Friction not only increases the brightness of their light, but restores it when apparently extinguished—By means of this friction the phosphorescence may be communicated to water, but much more strongly to fresh than to salt water—Beautiful phosphorescences produced in well-water by squeezing some medusæ in it—This phosphorescence, when it had ceased, again appeared on shaking the water—Artificial heat more proper than that of the atmosphere to restore the light of the water when agitation alone is insufficient—Human urine, both with regard to the intensity and duration of this phosphorescence, not inferior to fresh water—No liquor in this exceeds milk—Pleasing appearances produced by this phosphorescent liquor when poured into a glass, or when the hand is plunged into it—This phosphorescence in milk when lost may be restored by throwing it forcibly against any hard body—These phenomena more conspicuous in milk than in other liquors—The phosphorescence of these medusæ

ſæ does not extend to the whole of their bodies—No appearance of light in the umbella except at the edges—The light very ſtrong in the larger tentacula, and feeble in the purſe that communicates with an aperture in the umbella, which, probably, is the mouth of the animal—This light diſcovered to reſide in a rather thick and adheſive humour, which moiſtens and covers the three parts above mentioned—This humour muſt be recent to be endowed with its luminous quality—Great difference between theſe meduſæ and others that the author had before obſerved in other ſeas, which do not become phoſphoreſcent till they putreſcy and become fetid; directly contrary to what is obſervable in theſe—Theſe meduſæ contain two humours; the one in conſiderable abundance, ſalt, and not offenſive to the taſte; the other much leſs in quantity, acrid, nauſeous, and, when applied to the ſkin of the more tender parts of the body, cauſing a diſagreeable ſenſation—The meduſæ uſually frèquent thoſe parts of the ſea that are calm—Different names by
which

which they are known at Messina and in the Lipari islands—Probable that they feed on small fish—Manner in which they take their prey—Conjecture that they are true hermaphrodites—A new species of medusa characterized—Two kinds of sea glow-worms observed by the author in his travels in Sicily, similar to those he had some years before noticed in the Gulph of Genoa, the Archipelago, and the Black Sea.

AMONG the animals which from their tenderness of body have been ranked by systematic naturalists in the order of Mollusca, there is a singular genus, well known to the ancients, and denominated by some moderns sea-nettles, by Reaumur sea-jellies, and by Linnæus medusæ; appellations, all of which have an allusion to some exterior character of these animals; it having been observed, that on touching them they produce a pungent sensation like the nettle; that, being handled, they dissolve between the fingers like a jelly; and that, from their strange form, they in some measure resemble the
head

head of the fabulous Medusa: Aristotle, who wrote in Greece, and Pliny, who, long after, copied him in Italy, were the first who gave some imperfect accounts of the life and habits of these curious animals. I know of no authors who have since written on them, Reaumur and Dicquemare excepted. The former, in the Memoirs of the Royal Academy of Sciences at Paris for the year 1710, has considered, in an essay of some length, the manner in which the local motion of some species of medusæ is effected; and the latter, in several memoirs in Rozier's *Journal de Physique*, has examined their organic structure and various motions. Neither of these authors, however, has made any mention of a remarkable quality in these medusæ; I mean, that they are phosphorescent. I do not know that this species has hitherto been described: I only know that Læssingius asserts that he had seen it, according to what Linnæus says in his *Amœnitates Academicæ* in the following words:

"Doctissimus Læssingius, inter Hispaniam
VOL. IV. P "et

“ et Americam, vidit, in alto mari, medusas
 “ aliaque zoophyta, pacatâ aquâ, dispersa
 “ per æquora, et noctu instar totidem cande-
 “ larum lucere, et exortis ventis sensim sub-
 “ sidere et lucem suffocari.”

“ The learned Lœffingius saw in the sea
 “ between Spain and America medusæ, and
 “ other zoophyta, dispersed over the water,
 “ when calm, and shining in the night like
 “ so many candles. When the wind rose,
 “ they gradually sank, and their light dis-
 “ appeared.”

But this account is much too concise and
 imperfect to be satisfactory, and serves ra-
 ther to excite than gratify our curiosity.
 Nor am I surprised at the want of precise
 observations relative to this phosphorescent
 quality, as the medusæ which are possessed
 of it are extremely few compared with those
 which are destitute of it. I had an oppor-
 tunity of examining many of them in the
 sea of Genoa, as also in the Adriatic, the
 Archipelago, and the Thracian Bosphorus ;
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but I did not find one which was luminous by night. I only met with these by a kind of fortunate accident in the Strait of Messina, and first discovered them when, after my excursion to the rock of Scylla, I returned to that city. As I remained there several weeks, not only to observe Charybdis and Scylla, but also the animals taken in the fisheries in that Strait, and the fossil productions of the mountains and hills in the vicinity, I had sufficient opportunity to examine and study this species of medusa, of which there are great quantities in this channel of the sea. But it is not possible to give the reader a clear and precise idea of this phosphorescence, without first briefly describing the organization of these animals, and the manner in which they swim in the water, and transfer themselves from place to place, both of which have a direct and immediate relation with their luminous quality.

With respect to the first: the form of the body of these medusæ may be compared to the umbella of a fungus, convex on the

upper part, and concave in the under, the diameter of which may be two, three, or four inches, according to the size of the animal. And as the umbella in many fungi becomes thinner towards the edges, the same is observable in the umbella of these animals (for by this name I shall continue to call it), which likewise is cut at the edges into a kind of fine fringe. Where the concavity of the umbella in the fungi is attached to the central stalk, we find adherent, in that of the medusæ, towards the middle, four long cylindrical bodies, which, with the systematic naturalists, I shall call tentacula, or feelers; besides eight other lateral ones, which are much thinner, and adhere longitudinally to the internal sides of the umbella. But this general description requires a more circumstantial detail.

The umbella of each of these medusæ in the external parts is slightly convex, and here the surface is extremely smooth, and covered with a humid slime, even when the animal is out of the water. It is thickest

in the highest parts, and becomes gradually thinner in the lower. In the highest part of its cavity is an aperture which opens into a kind of gelatinous purse, communicating with four lateral orifices. By these the sea-water enters, and issues again by the aperture; and that which again has entered the aperture passes through the purse, and goes out at the four orifices. I suspect this aperture to be the mouth of the animal; and that the purse acts the part of a stomach, at least a receptacle, in which the food is digested; though I never discovered any within it, but always found it appear to be empty.

The substance of the umbella is so tender and delicate that it may easily be cut with a thread; it has also such transparency, that it is equal, in that respect, to the purest crystal. In the greater part of it, neither the anatomical knife, nor the eye assisted with the lens, can discover either vessels, fibres, or other dissimilar parts, which are found in almost all animals. It presents the appear-

apices of a perfectly simple homogeneous jelly; and, at the top of the cavity, we discover four small groups of long thin bodies, entwined together, and formed like intestines, adhering to an entangled mass of small, extremely transparent tubes, of a silver colour, and with sides sufficiently elastic to preserve their round figure when cut transversely. From the repeated examinations I made of them, I was convinced that they do not convey any kind of liquor. The great analogy they have to the tracheæ of insects might induce us to suppose that these tubes are intended for the same use. At any rate it cannot be improper to call them tracheæ-form tubes.

In the same manner as in the highest part of the cavity of the umbella we discover the small organized bodies above described, we likewise observe, at the internal edges of the same, another organized structure, consisting of a very thin muscular membrane, which rises from the bottom about half an inch or a whole one, according to

the

the size of the medusa. Where this membrane exists, the great transparency of the umbella is somewhat obscured.

We will, now proceed to speak of the tentacula:—and first of the largest, which we have said to be four in number. These in their lower part grow out of the edges of the umbella, and by their higher are attached to the upper parts of its cavity, including in the middle the aperture which we have conjectured to be the mouth of the animal. Each of these has a slight longitudinal furrow, terminated by two membranous appendages, moistened by a viscous humour. On examining them internally, they are found to be composed of small muscular fibres, closely entwined, and extended lengthwise. In the middle of them there is a channel running their whole length. They are sufficiently transparent for this to be visible. It contains a number of globular molecules, which, by a pressure of the finger on the tentacula, may be put in motion; and they may be made to issue

from the lower part of the tentacular, or from any other point, by cutting the latter transversely.

The eight other lateral tentacula are much thinner, but longer. They have the same muscular appearance, and are perforated in the middle through their whole length.

The tentacula, therefore, both large and small, may be considered as vessels or channels, though, as we shall see presently, they are likewise destined to other uses. I must observe, however, that no circulation or motion of the fluids of these medusæ has been discovered by the most careful and minute examination, with the best microscopes. The body and the tentacula of these animals are of a transparent light blue, without any mixture of other colours, with which some other species are pleasingly variegated.

On taking one of these medusæ in my hand, it did not suddenly dissolve, as others have been described to do. It remained at
first

first entire, even when rubbed between the fingers, which, on pressing it, felt a moderate resistance. After some minutes it began to give out water, which it continued afterwards. This effect was not produced either by the warmth of the hand or the pressure; at least the latter only accelerated it. When the medusa is laid on a table, or any other body, a moisture begins to drop from it, and continues to do so, till the whole is changed into an extremely transparent liquid. Some of these medusæ weighed fifty ounces; and the liquor into which they are gradually reduced being carefully collected in a vessel, was found to want in weight very little of those fifty ounces. The small difference may probably be occasioned by the part of the liquor which evaporates during the dissolution of the medusa. What remains is only some thin dry pellicles of the weight of about five or six grains. This liquor, when tasted, has the saltiness of sea-water, and when evaporated to dryness leaves in the vessel a quantity of muriate of soda (sea-salt), somewhat

what less than an equal quantity of sea water would furnish. This salt taste is equally perceivable on touching the medusa with the tongue, either during its actual dissolving, or when it is first taken out of the sea and washed in fresh water; provided, in the latter case, it be touched in a part where it has been cut. It is therefore evident, that the sea-water, penetrating the organic texture, constitutes the greater part of the volume of these animals. This property is, in my opinion, extremely singular; at least, among the various marine mollusca that I have examined, I do not recollect to have met with one of a similar kind.

I must likewise observe, that this dissolution of the body of the medusa not only takes place when it is kept out of the water, but even while it continues in sea-water contained in vessels, if these are too narrow, and the water not frequently renewed. The cause in both cases is the same; and is, no doubt, the injury and fracture of the solid parts, occasioned by the removal of the medusa

medusa from its natural state ; in consequence of which, the liquids, being no longer confined within the body, gradually ooze out. It is, therefore, sufficiently evident that, notwithstanding we can discover no appearance of organization in the greater part of the body of the medusa, we cannot deny that it exists ; at least we are forced to admit a delicate spongy and bibacious substance, which attracts and retains within it the sea-water, though from its transparency, and, perhaps, likewise from the extreme fineness of its texture, it is not visible.

Having thus sufficiently examined the form and structure of our medusa, we will now proceed, as was proposed, to describe their natural motions ; which may be considered as the principal attribute that characterizes them as real animals.

These motions do not differ from those of the medusa which are not phosphorescent, and consist in an almost continual constriction and dilatation of the umbella. When,
from

from a boat, we attentively observe a swimming medusa, while the sea is calm, we perceive that it turns the convex part of the umbella in an oblique direction to the surface of the water, and that the edges occupy the place behind. These, every five or six seconds, suddenly contract, and a moment after enlarge. The medusa, which is always immersed in the water, and, consequently, has the cavity of the umbella constantly full of it, at every contraction, or systole, presses out the included water, forcing it against the internal parts of the umbella, by which impulse the medusa proceeds one step. Soon after it causes another systole, by which, receiving a new impulse from the water, it again moves forwards; and this systole being incessantly repeated, and followed a moment after by the dilatation, or diastole, the animal has a slow progressive motion through the sea. At the same time the tentacula stretch out from the edges of the umbella, extended, and grouped together. This reciprocal motion, which hereafter, for the sake of brevity, I shall call

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oscillation, is necessary to enable the medusa to swim, and remove from place to place; otherwise it would sink to the bottom, as it is specifically heavier than the sea-water.

This latter fact I was certified of, not only by the experiments I made in the Strait of Messina, but by attentively observing several medusæ in vessels filled with sea-water. In these likewise I could perceive several circumstances relative to the oscillation, which it was impossible to discover while they remained in their native habitation. I could, for example, ascertain how much the periphery of the umbrella, which approached to that of a circle, contracted at every systole; and perceived that the contraction was about two, three, or, at most, four lines. I saw that the oscillation resided only in the umbrella, and that it was entirely independent of the purse and the large and small tentacula: since if all these parts are cut away, the oscillation will continue exactly the same. I perceived likewise, that though this motion extends through the whole

whole of the umbrella, a great part of it only moves by a consentaneous vibration.

This the following experiments evidently proved. I raised a circular piece of the umbrella, an inch in diameter, towards the upper parts, cutting it transversely and parallel to the edges. This piece no longer oscillated, and was insensible to any stimulus; though the oscillation still continued for a long time in the remainder of the umbrella. This remainder I diminished still more, by cutting, transversely, another circular portion from the umbrella; which portion likewise no longer manifested the least sign of oscillation. By repeated sections of this kind, I, at length, discovered the seat and origin of the oscillation in these medusæ. I have already mentioned a fine muscular membrane which extends from the edges of the umbrella a certain space, and stretches over its inner sides. This, when viewed with the lens, is found to be composed of an immense number of carnos transversal fibres, parallel to each other, and closely adhering

hering to the gelatinous substance of the
 umbella. On the action of these transversal
 fibres, and their relaxation, depends the
 whole play of the oscillation. As often as
 they are shortened, the portion of the um-
 bella to which they are attached is forced
 to contract; in consequence of which the
 same contraction extends to the remainder
 of the umbella. This produces the systole
 of the medusa; from which we easily un-
 derstand the nature of the diastole, which
 results from the relaxation of the same fibres.
 So long, therefore, as we take from the
 umbella a part in which there are none of
 these muscular fibrillæ, it will, when de-
 tached, have no oscillation; but this is not
 the case when it is united to a portion of
 them, as I have satisfied myself by observa-
 tion and experiment. When a circular piece
 of the medusa, which contained no carious
 fibres, was cut out of the medusa, and, for
 the greater convenience and precision in the
 experiment, laid on a dry table, it did not
 oscillate; but it had this motion, and it
 continued for a long interval if it was sur-
 rounded

founded by these fibres; and, when the ring which contained these fibres, and which, in the larger medusæ, is about the breadth of an inch, was laid alone on the table, it was curious to see in what manner it became considerably narrower at every systole.

These experiments led to others, which I shall here describe. I cut, transversely, the ring which contains the muscular fibres into several pieces. Each of these pieces oscillated; and, in them, the play of the fibres in action was visible in an extraordinary manner. From time to time they suddenly became shorter, and then the piece which contained them became likewise shorter and thicker: a moment after, they returned to their former length, and the containing piece became thinner and longer. The motions of the cut pieces resembled those of a worm, which, as it glides along, first lengthens and renders thin its body, and, afterward, shortens and thickens it.

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I detached, with a very small pair of pincers, the muscular membrane from a portion of the ring; when the oscillation immediately ceased; as it likewise did if the fibres were only cut in several places.

From these experiments I naturally concluded: First, that the seat of the oscillation is placed in the above-described muscular membrane: Secondly, that the gelatinous part of the umbella oscillates from the immediate communication it has in the lower parts with this membrane: Thirdly, that the oscillation does not cease though the medusæ be transferred from their native element to the land. During twenty-four hours, some of the largest medusæ, being laid in a dry place, did not cease to oscillate, notwithstanding they had dissolved till they scarcely retained one third of their substance. Towards the expiration of this time, indeed, the oscillation became feeble, slow, and interrupted. But, when it appeared to have entirely ceased, it might frequently be renewed by friction, or punctures made in

the muscular membrane of the umbrella. Even when the gelatinous ring to which this membrane is closely attached was taken out of the medusa and cut in pieces, every piece, by these means, might be made to resume, for some time, its oscillation; which, in short, only ceased when the group of transverse fibres was either dried up for want of moisture, or corrupted and destroyed from excess of it.

This pertinacious continuation of motion in the medusæ, when dying and severed in pieces, may be thought an incontestable proof that this motion is independent of the will of the animal, like the pulsation of the heart of a frog, tortoise, or serpent, when taken out of the thorax of those creatures. I will not, however, venture absolutely to affirm this. I have frequently observed the swimming medusæ in the shallows of the Strait of Messina. Some of them, after having, by their oscillation, sustained themselves for some time at the surface of the water, ceased to oscillate, and gradually

gradually sank to the bottom by their own weight. There they remained motionless for a quarter of an hour, half an hour, or more; when, resuming their oscillation, they began, by degrees, to ascend, and rose to the surface of the water. Other medusæ, if the depth of the water were, for example, four feet, would sink in it two; and then, their oscillation recommencing, return to the surface. Does not therefore the cessation of this motion, and its renewal, in these circumstances, appear to depend on the will of the animal? I leave it to the enlightened reader to form his own judgment, contenting myself with a simple and faithful narration of facts.

I cannot omit to mention a motion of another kind which is observable in the long and short tentacula, and in the long and thin parts formed like intestines. With respect to the former, the motion in them may be better observed when they are detached from the medusa than when they make a part of it. If therefore they are separated

from the cavity of the umbella to which they are fastened, and laid in the palm of the hand, a slight motion is perceivable in them, which becomes much more sensible in their membranous appendages, and continues in the latter when divided from the tentacula. This motion, however, soon ceases, though these parts should have been separated from the medusæ that were most vigorous and full of life.

More durable, and likewise stronger, is the motion in the parts formed like intestines, which, as we have said, compose, as it were, four small skeins of fibres situated near the lateral orifices of the umbella. If these are left in the same situation, or taken out of the animal, and laid dry on a table, or in the sea water, they present the same appearances as the intestines, for example, of a dog when taken out of the living body and observed. We know that the intestines for some time do not cease to exhibit the peristaltic motion, resembling that of worms or small waves undulating from side to side.

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We know likewise, that when all motion has ceased, it may be again, in some degree, excited, at least for a certain time, by means of stimuli. Similar motions I discovered in the abovementioned parts, which, as I found them hollow within, and containing in their cavity an extremely liquid and delicate matter, I do not greatly hesitate to believe to be true intestines. The composition, besides, of their coats, as also that of the tracheæ-form tubes, is of a different kind from that of the rest of the body. At least, when the latter is nearly consumed by dissolution, both these kinds of small tubes still remain entire; and in those which are formed like intestines, the vermicular motion still continues.

Having thus described the organization and motions of these medusæ, it now remains to speak of the singular property they possess in being phosphoric, and which was the primary object of the present account.

If in the beginning of the night we enter the Strait of Messina in a low bark or boat,

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coasting near the land, where the water is perfectly calm, the medusæ, which are usually very numerous there, begin to shine with a light, which, as the darkness increases, acquires intensity and extent; every medusa resembling a bright torch, that may be seen for some hundred paces round; and on approaching it, the brilliant phosphorus shews the form of the body. This light, when the evening twilight is extinct, is of a lively white, which strikes the eye even when the animal is five-and-thirty feet below the surface. As the medusa, by its oscillation, transfers itself from place to place, so the light is variable, and is stronger in the systole than in the diastole. Sometimes it continues for a quarter of an hour, half an hour, or more; but at other times it suddenly becomes extinguished, and does not re-appear till after a considerable interval. This interruption of the light induced me to suspect that it might depend on the oscillation of the medusa, which remaining for some time suspended, might likewise suspend the phosphorescence. Thus we know the

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little phosphorus of the terrestrial flying glow-worm is interrupted, being lighted up by every motion of the body, and extinguished in the moments of rest. A similar alternation I likewise discovered in the marine glow-worm (*Nereis marina* Lin.).

It was not, however, very practicable to make such observations on the animal, while in the sea, as should ascertain the truth or error of this conjecture. I therefore applied myself to examine the medusæ in vessels filled with sea-water, in which they would remain alive several days if the water were frequently renewed and the vessels were large*. In these the phosphorescence being not in the least inferior to that they possessed when in the sea, I could distinctly perceive, that so long as the medusæ uninterruptedly oscillated the phosphorescence continued, only that it was more vivid in the systole than in the diastole, as I had observed in the sea.

* This experiment, and those which follow, relative to the phosphorescence of the medusæ, were almost all made in the night, and in the dark.

But when the oscillation ceased, either entirely or at intervals, the phosphorus was so enfeebled that, to inattentive eyes, it would appear entirely extinct. Of this the following fact is a proof :

In the chamber in which I slept at Messina, I had kept, for several days, a number of medusæ in buckets filled with sea-water. In one of these, the water having been neglected to be changed, the medusæ it contained had greatly suffered, and no longer oscillated when I returned to them, which was in the evening, soon after sunset. The phosphorus then no longer appeared, except when by handling the medusæ they were made to oscillate, for a short time. During three successive hours, in that night, I remained in the same chamber, sitting at a table to note down the observations I had made in the course of the day ; and in that time, having twice cast my eyes on the bucket, I found it entirely dark, though the candle had been removed into another room. But rising before day, and approaching the bucket, which

which stood in one corner of the chamber, in the dark, I perceived that the dying medusæ still emitted a pale, indeed, but very apparent light, which I discerned at some distance from the vessel, and while it remained perfectly undisturbed.

It was easy to repeat this experiment on other medusæ, and such a repetition was of importance. The result was exactly the same. I found likewise that the medusæ did not entirely cease to shine till they were dead and began to putrefy. I therefore concluded that the phosphorescence of these animals cannot properly be said to be interrupted; but that during the oscillations it is stronger and more lively; though a feeble light still continues in the intervals of rest, so weak indeed that it cannot be discerned unless the eye be cleared of the impressions of light from surrounding objects, as was mine, when, after having slept in the dark room, I proceeded before day to make observations of this kind: a practice which, taught by experience, I found very advantageous

rageous in several other experiments on the phosphorescence of these medusæ, which I shall hereafter relate.

If the medusæ, instead of being kept in their native water, are left in a dry place, the light continues very clearly discernible, as long as the oscillation lasts, that is to say, for a short time; but insensibly decreases in proportion to the diminution of that motion. The same is equally observable when they are kept in the vessels. In this case, likewise, the feeble light in the intervals between the oscillations is discoverable.

With respect to the medusæ which were kept out of the water, a fact presented itself to my observation, which, from its extraordinary nature, I should have supposed accidental, had not the same result followed on repeated trials. A medusa having been left two-and-twenty hours on a sheet of white paper had ceased to live; the greater part of it was even dissolved into a liquor, and every luminous trace was become extinct.

A large

A large glass full of well-water happening to stand on the table, I, without any particular intention, chanced to throw the medusa into it, which directly sank to the bottom, and remained there motionless; but, to my great surprise, immediately shone with so bright a light that I was able to read characters of a tolerable size. The water at the same time became very luminous, and on immersing my finger in it, it was plainly discernible. Thinking that the same would happen, and perhaps with more effect, if sea-water were used; I threw the well-water out of the glass, and filled it with sea-water. But no light was now visible. I substituted fresh water for salt, and a beautiful phosphorus again appeared.

Analogous to this phenomenon, of which I am unable to assign the cause, was the following:

Another medusa which was dead, and had not been luminous for some time, was lying, out of the water, in the window of my

my chamber during the night. A slight rain chanced to fall, and every drop which fell on the dead medusa was changed into a brilliant spangle, till in a short time the medusa was studded all over with such shining points. I could produce no such effect by sprinkling it with sea-water in imitation of rain,

Hitherto we have principally considered the light of the medusa as it presents itself naturally; we will now make some observations on it as it is excited by art. The motion of the parts of the medusa not only will increase its light, but rekindle it when it is apparently extinct. When they are brought from the sea to the vessels, their phosphorescence is extremely brilliant; and its intensity especially increases if they are taken between the fingers and shaken in the water, or when their body feels the pressure of the hand. In like manner, when the light is enfeebled by long continuance in the vessels, it may be re-invigorated by friction. The effect is the same when they are kept out of the

the water. When, therefore, all appearance of light has vanished, it may be suddenly restored by the means above mentioned. These augmentations and revivings of the phosphorescence, however, are transient, and continue but little longer than while the friction or agitation is applied. The re-appearance of the light, likewise, does not take place except when some entireness in the parts of the animal is preserved; otherwise the action of the hand or any other body is to no purpose.

When the medusa is handled or rubbed in the water, the quality of phosphorescence passes into the latter; which it likewise does when the animal is left immersed in it. But this experiment succeeds much better in fresh than in salt water; as I have observed that, other circumstances being equal, the brilliancy of the former is nearly double that of the latter. We may, therefore, by means of these medusæ, create artificial phosphori.

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For this purpose I employed well-water, as being more suitable, and with it made several experiments deserving attention. In thirteen ounces of this water, contained in a crystal glass, I squeezed two large medusæ, which had just been taken out of the sea. The water became somewhat turbid, but at the same time so luminous, that it gave sufficient light to a whole room. After two-and-twenty minutes it began to grow feeble, and at the end of an hour and a half was entirely extinguished. Agitation, however, then restored it, in the same manner as we have said it revived the phosphorescence of the medusæ when it appeared to be extinct. If, therefore, the water in the glass was stirred with a stick, or even with the finger, the brightness re-appeared, but was always feebler in proportion to the time elapsed. I observed, likewise, that the greater the agitation of the water, the brighter was the phosphorescence, which, however, when the water was no longer agitated, had only a momentary duration, as we have before remarked of the medusæ.

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When the water can no longer be excited to phosphorescence by the motion of its parts, it may by the application of warmth. I made the experiments I have related, in a temperature of between 21 and 24 degrees of Reaumur's thermometer (80° and 86° of Fahrenheit); and if in this temperature the water in the glasses, though strongly shaken, emitted no light, it became lucid when the thermometer rose to 30° (100° of Fahr.) and still more vivid in a higher temperature, provided it was not too high, for then it entirely ceased.

I made this experiment with other liquors besides water, and found several, which I had imagined unsuitable for such a purpose, might be impregnated with the light of the medusa. Such, for example, was human urine, which, in the intensity and duration of its phosphorescence, was not inferior to fresh water. But the experiment succeeded better in no fluid than cow's milk. A single medusa, of a moderate size, being pressed and shaken in twenty-seven ounces of this milk,
rendered

rendered it so luminous that I could read the writing of a letter at three feet distance. The duration of this phosphorus was likewise greater than that of the water. After eleven hours from the time I first put the medusa into it, it still retained some light; and when that ceased, agitation restored it, as did warmth, when agitation alone became ineffectual.

Repeating the experiment with the same milk, I poured it out of the glass upon the floor of the room, in order to observe the appearance it might produce. While in the air, it exhibited a kind of very white and shining cataract, and, when it reached the ground, formed a little lake of light, at first vivid, but which, in a few moments, grew feebler, and, in about five minutes, entirely disappeared.

If the hand were immersed in the phosphorescent milk, and drawn out again, it appeared elegantly silvered over; but this colour soon vanished; though it might be made

made to return for a moment by rubbing or warming the hand. This light not only attached to the hand, but to cloths; as I perceived in a towel, one edge of which had touched the luminous milk. In this case, likewise, the re-appearance of the light might be obtained by rubbing or warming the cloths.

While employed in these experiments, I observed that throwing the milk against any hard body would restore its phosphorescence when extinct. The same milk, which emitted no light on the strongest agitation within the vessel, when let fall upon the floor became luminous; and the more violent the blow, the brighter was the light. Thus, if by night this liquor was poured from a high window, while it was in the air it had no luminous appearance, but, as soon as it struck the ground, shone with a bright light; which, however, presently grew feeble, and disappeared.

These appearances, it is to be observed,

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were not confined to milk exclusively of all other liquors; they were likewise exhibited by fresh water; but the vividness and duration of the phosphorus were greater in the milk than in any other fluid with which I made the experiment.

A question which I considered as of importance, and endeavoured to resolve with every possible attention, presented itself in the course of these enquiries—Does the phosphorus extend over the whole body of the medusa, or only reside in certain parts? It was impossible to attain the solution of this problem by observing the animal when swimming in the sea. Besides that the tentacula, from their situation, are then, in part, covered by the umbella; the spontaneous agitation of the medusa, and that which the sea usually has, only allowed me to discern a globe of light. I could therefore only prosecute my enquiry on this subject by examining the medusæ, kept in sea-water, in vessels which I procured of glass that I might be able to see the whole body of the animal

animal while it shone in the dark. But at first I did not obtain that satisfactory elucidation which I sought.

A medusa taken fresh out of the sea, and placed, full of life and vigorously oscillating, in a vessel filled with fresh sea-water, appeared luminous in every part; only that the light was more vivid in the large tentacula, and at the edges of the umbella. I was doubtful, however, whether the feebler brightness of the other parts was derived from those more resplendent, or whether they had a weaker light of their own. I waited till the oscillation had ceased by the approaching death of the animal. We have already said that even then some light is discernible, provided our eyes be cleared from the light of all surrounding objects. My doubts now began to be elucidated.

When all motion had entirely ceased in the medusa, the edges of the umbella shone feebly, while the other parts of it were quite dark, and the larger tentacula somewhat

more vividly than the edges. I suspected, therefore, that the true seat of the phosphorus was in these parts, and the facts I shall now proceed to relate satisfied me that I was not mistaken. If the umbrella of a medusa, immediately after the animal is taken, be cut with a pair of sharp scissars, so that the edges are separated from it in a ring of about five or six lines in breadth, and the finger be passed over this ring, a phosphorescence will be manifest in every part that is touched. In like manner, if the ring be cut in pieces, every piece, on being touched, will become luminous, and continue so for some time. On the contrary, the remainder of the umbrella, deprived of the tentacula and its other appurtenances, though containing incomparably more of the substance of the animal than the ring, remains totally dark, however it may be rubbed, pressed, cut, or stimulated in any other manner.

It is to be observed, that all that part of the ring which is phosphorescent is internally covered

covered with the muscular membrane which we have before mentined. May not this, therefore, be the cause of the phosphorescence, or at least concur to produce it? I have discovered that it is not; since, if it be entirely taken away, the phosphorescence continues as before: and I have also found that this light depends on a somewhat dense and viscid humour which moistens and covers the bottom of the umbella, and which will be presently described more at length.

But there is no part of the animal which shines brighter than the largest tentacula. If these are taken, either separately or united together, between the fore finger and the thumb, and the two fingers are passed over them from one end to the other, a line of very vivid light is produced which continues some seconds; and the experiment succeeds in the same manner when the tentacula are detached from the animal. It may be repeated eight, ten, or even twelve times with equal success, except that the light continually becomes fainter. The reason is

very evident. Here, as at the edges of the umbella, the phosphorus resides in the dense and viscid humour; which, by repeated friction, is carried away by the fingers, to which it adheres; until at length the light entirely ceases. The same is true of the edges and the purse attached to the internal upper part of the umbella; since that likewise, when touched, has some phosphorescence, the surface of it being moistened by the viscid humour. I made numerous and different experiments of these animals, but I could find no other parts of them which possessed this luminous quality but these three: that is to say, the large tentacula, in which it principally resides; the edges of the umbella, which are next with respect to the vividness of their light; and the purse communicating with that aperture of the umbella which is perhaps the mouth of the animal, and in which the light is feeblest. These phosphorescences take place whether the animal be in or out of the sea-water; but they are most vivid in the former case.

That this humour, as far as can be discovered by our eyes, is the cause of the light in these medusæ, is still more confirmed by the following facts: If either of the three parts above mentioned, but especially the larger tentacula, be rubbed between the fingers in the night-time, a portion of this humour will adhere to them, and the fingers become vividly phosphorescent. If the roots of the tentacula be grasped in the hand, and it be drawn along to the ends of them, the whole palm will become luminous, and at the same time clammy. If the same action be repeated, the same light will reappear, as long as any portion of the viscous matter shall remain; but, when that is entirely exhausted, the phosphorescence will cease. When I handled the remainder of the body of these animals, I found no viscid matter adhere to my fingers, nor was any luminous appearance produced. If this humour be scraped off with a knife, and put into a glass filled with water or milk, and stirred with the finger or a spatula, both those fluids will become phosphoric;

which they will not when the moisture expressed from any other part of the medusa is mixed with them. It hence appears, that when the body of the medusa is squeezed in any liquor, it is not every portion of it which communicates the luminous quality, but those parts only of which we have been speaking; that is, the large tentacula, the purse, and the edges of the umbella. It is necessary, also, to this phosphorescence, that these should be taken from a living medusa, or one that has very recently ceased to live; otherwise, as they will be incapable of emitting light, they cannot communicate that property to other bodies.

We may here remark the great difference there is between these medusæ, and many others which I have observed in other seas. The latter are not phosphorescent either living or recently dead, but only when they corrupt and become foetid: those, on the contrary, of which we now treat, produce, as we have seen, effects entirely opposite.

From

From the observations and experiments contained in this chapter, it is sufficiently evident that the liquor produced by the dissolution of the medusa is different from that which is phosphoric; since the former extends itself through, and penetrates, the whole body of the medusa, and the latter has its residence only in three particular parts. The following facts will briefly corroborate this proof: When the tenacious liquor is expressed from the larger tentacula, the phosphorescence, as has been said, entirely ceases; though another fluid still continues to issue from them till their entire dissolution. When these tentacula, also, are cut transversely from a medusa recently taken, and consequently very luminous, the surface of the section is dark, though abundance of moisture issues from it; and the light only appears on the surface which has not been cut, that is to say, where the phosphoric moisture resides: they are therefore two different substances. It is true that, from want of the requisite means, I was not able to analyse them chemically; but the sense

of

of tasting sufficiently discriminated them. The liquor into which the phosphoric medusæ are resolved is, as we have seen, very salt; which saltiness it derives from the muriate of soda with which it abounds. It is not surprising, therefore, that it is no otherwise disagreeable to the taste. But the phosphoric liquor has a very different effect, and is even painful to the delicate parts of the skin if it accidentally touches them. My curiosity twice induced me to taste it with the tip of my tongue. The sensation it excited was that of a burning smart, which lasted more than a day. A similar sensation, but much more painful, I experienced in my eye, from a drop of this liquor casually flying into it. Even the back of the hand felt a slight pain when long applied to this animal.

I must not omit to notice, that the excitement of this troublesome pruritus is not confined to this phosphoric liquor, since I have experienced the same sensation on touching medusæ which were not phosphorescent

rescent in the Gulph of Spezia, as I have remarked in an Essay published in the *Memoirs of the Italian Society*. We hence understand why Aristotle and Pliny called these mollusca *sea-nettles*; though it is certain that some species of them are innocent; as those which were examined by the illustrious Reaumur, on the coast of Poitou, and those which I met with in the Strait of Constantinople and other places.

A few more remarks only remain to complete the history of these animals. I made the observations and experiments here described, in October. The Strait of Messina was then full of them, especially in the vicinity of the Lazaretto, where the water was calm. The parts of the sea which are the calmest are most frequented by them; at least it is certain that, however strongly the medusæ oscillate, they cannot resist the agitated waves, but are driven to the shore by them, as I have seen in other parts of the same Strait. At Messina they are called *bromi*; and I was assured by the sailors that
they

they are found there in all seasons. In my excursions round the shores of the Eolian isles, I only saw two in the night-time in the channel of Vulcano, which I discovered by their phosphorescence, and found to be of the same species with those now described. At Lipari they are well known, and called by the expressive name of sea-candles (*candellieri di mare*).

I once, in the same Strait, observed one which had a small fish sticking to its tentacula, being held by the viscous liquor; and the fishermen assured me that this might be frequently seen. It seems probable, therefore, that these small animals, and others similar, are the food of the medusæ, and that the tentacula are a kind of net in which they are taken by the aid of the viscous liquor, though they are likewise destined for another use, as that of giving light. I find that this was the opinion of Pliny.

I have some suspicion that these mollusca are hermaphrodites, or that every individual

dual is capable of propagating its species without commerce with another, as is observable of many other marine animals of the class of vermes. This conjecture I do not merely found on my never having observed two coupled together, but on the sameness of organization in all that I have examined, which were in number more than a hundred. The extreme transparency of their bodies afforded me an opportunity of observing their internal parts, and endeavouring to ascertain whether they were produced by eggs or foetuses; but with respect to this I could arrive at no certainty. In some of the larger sized, I could perceive, at a small distance from the minute tracheæ-form tubes, numerous aggregates of globules, which I never discovered in the smaller medusæ; and in others, more corpulent, I observed these globules still larger; which induced me to surmise that these globules might be eggs. But the necessity I was under of leaving Messina, compelled me, much against my will, to desist from my enquiries on this subject.

This

- This new species of medusa may be thus characterized—*Medusa phosphorea orbicularis convexiuscula, margine fimbriato, subtus quinque cavitatibus, tentaculis quatuor crassioribus centralibus, octo tenuioribus laterali-bus longioribus.*

Having thus described one marine animal which emits light, I will conclude this chapter with mentioning another which is very small, but extremely numerous—I mean the sea-glow-worm.

Signor Vianelli di Chiozza is well known to have been the first naturalist who discovered one species of them. He shewed that the light which in the darkest nights illuminates the Venetian Laguna, especially when the water is struck by the gondola's oars, or any other body, proceeds from these minute animals, which are immensely numerous in that lake.

A light of the same kind, proceeding from the same or a similar animated principle,

ple, I have observed in the Mediterranean ; that part of it, at least, which washes the eastern coast of the territory of Genoa ; where, besides the marine glow-worm or shining nereis of Vianelli, I discovered five new species *.

In the sea which furrounds the Eolian isles I found no such animal phosphorus. In that of Sicily it was not wanting. In my voyage from Lipari to Messina and Catania, and on my return to Lipari, I was three times obliged to pass the night on the water. The sea was here shallow, and the bottom abounded with sea-weeds. These plants in the darkness of the night shone with sudden and bright flashes, which became more numerous when I moved them with the end of an oar, and induced me to suppose they contained marine glow-worms. Having drawn up some tufts of them from the bottom, I found, in fact, these animals attached to them ; and that they were the

* See the Memoirs of the Italian Society, t. ii. p. ii.

cause of their luminous appearance. That I might examine them more accurately, I carried them with me to Messina and Lipari, in vessels of sea-water; where, in a dark room, I detached the glow-worms from the sea-weed, either by taking them off gently with my finger, as their light shewed me the precise spot where they were; or by shaking the leaves of the plant in the water, first placing a cloth at the bottom of the vessel, upon which they fell, as they were specifically heavier than the sea-water. The cloth then appeared studded with lucid points, which were the glow-worms I wished to detach. Examining them with the lens, I found they were of two species. But as they do not differ from those of the Gulph of Genoa, I shall reserve the description of them for the account I purpose to publish of my voyage to Constantinople, to which I shall add the observations I made in the Mediterranean and the Adriatic. It is evident, however, that the Laguna of Venice is not the only place in which these phosphoric animals are found;

since they are met with, likewise, in the sea of Genoa, that of Sicily, and, as will appear in the work above mentioned, in the Archipelago, the Sea of Marmora, the Strait of Constantinople, and the Black Sea.

C H A P. XXVIII.

OTHER MOLLUSCA DISCOVERED IN THE
SAME STRAIT.

- I. *Description of a new species of ascidia*—
The sea-water enters its body by two aper-
tures, a superior and inferior—When press-
ed between the fingers, the water issues out
in two spouting streams—This water in-
sinuates itself into the internal part of the
animal, without producing that small ver-
tiginous current which the author observed
in several other marine animals—Evident
communication of one aperture with the
other—The superior aperture seems to be
the mouth of the animal, and the inferior
the anus—No other motion observable in
this marine worm but the opening and
shutting of the two apertures—Usual size
and colour of the larger ascidia—Several
minute animals sometimes found adhering

to them—Their coriaceous skin like a sheath which defends the tender body of the animal—When deprived of this skin, the animal still continues to draw in water through the apertures as before—Small longitudinal and transversal muscles, designed to produce some minute motions, though not apparent while the coriaceous skin invests the animal—Channel in the shape of a pear, which communicates with the lower aperture—Semitransparent vesicles included in this channel, containing a central globule—Small ascidiæ frequently attached to the larger without any internal communication between them—A viscous liquor the cause of their adhesion—The generation of this species of ascidia different from that of the polypi of Trembley—Conjecture that the globules contained in the vesicles are the eggs or rudiments of this animal—Characters which shew it to be specifically different from the tethyum of Bobadscb—Definition of this ascidia—II. Singular tentaculated animal frequently found adherent to coral when fished up in the Strait of

Messina—Its description—Species of systole and diastole in the longitudinal streak of the back—Fresh water a powerful poison to it—Uncertain to what genus of mollusca it belongs—III. A branching eschara, which seems not to have been hitherto described, vegetating on corals and other productions of that part of the sea—Its manner of growing, and its polypi—Small vertiginous current which the latter produce in the water, by which the minute particles proper for their food are conveyed to the mouth of the polypi—This current occasioned by the motion of their arms—In what manner the polypi retire at pleasure, and remain flat at the bottom of their cells—Their adhesion to the bottom of them—Polypi which have ceased to live in the old cells succeeded by those produced in the new—Probable that the new cells and the new polypi are the development of some germ of an old polypus—This eschara characterized—IV. Another species of polypus found in the channel of Messina, in which the circulation of the fluids is visible—Detailed description

description of these polypi and this circulation—Anomalies in the latter produced by various circumstances—In what temperature these polypi will continue to live when out of the sea, and in what they die—No appearance of an active principle in them productive of the circulation of their juices—Considered in itself, this circulation is as complete and perfect as it is observed in animals that rank much higher in the scale of animality—Definition of this polypus, which has been hitherto undescribed—

V. Observations on the motions of some echini spatagi (sea-urchins) found at the bottom of the Strait of Messina—They move from place to place, and fix themselves at pleasure by means of their tentacula, notwithstanding the agitation of the sea-water—Singular manner in which the tentacula act to produce this motion—The spines do not concur in producing this motion—Weight required to overcome the force of the tentacula which hold an echinus spatagus to the vertical sides of a glass vessel—A glutinous matter which every tentaculum emits,

the cause of this strong adhesion—Artifice which the *echinus* seems to use to free itself easily from its fastening—The tentacula always remain within the body when the animal is out of the water—Little or no progressive motion then observable in them from the agitation of the spines.

IF the surface of the Strait of Messina presented me with an interesting object in the phosphorescent medusæ, its bottom afforded me equal pleasure and instruction in the discoveries I made of other new and curious animals. These were brought up in the nets which detach the coral from the sub-aqueous rocks; a fishery of which I shall presently treat more at length.

I. The first which I shall describe is a species of the *ascidia*, hitherto not noticed, to my knowledge, by any author. The genus is thus defined by Linnæus—*Corpus fixum, teretiusculum, vaginans. Apertura binæ ad summitatem; altera humiliore.*

Its

Its form and natural dimensions are represented in Plate X. Fig. I; with two small ascidiæ attached to the larger. This ascidia is never found erratic in the sea; but always with the hinder extremity rooted, either immediately to the rocks, or to some stone or other hard body (Fig. ead. G). The upper extremity branches out in two obtuse projecting beaks; the one thicker and higher, and the other thinner and lower; both of which have in the middle an aperture, R. S. which is shut when the animal is taken out of the water, but gradually opens and remains open, as it appears in Fig. II. M. N. as often as it is suddenly put into a vessel of sea-water, if we wait till all agitation in it has ceased. The upper aperture then appears much larger than the lower, the former having the figure of a star with eight rays, and the latter that of a lesser star with seven rays. When the vessel containing it is shaken, the ascidia closes the two apertures, but quicker than it opened them; and it is observable that they both close or open at the same time.

There are some marine mollusca, as certain species of the holothuria, which, on being only taken into the hand, spout out the water they had imbibed in a stream. The present ascidia receives it by two apertures, and, in a certain manner, is saturated with it; but it does not eject it when it is gently handled. To cause this ejection it must be pressed between the fingers; when it spirts out the water, forming two thin jets or streams in the air. It may in this manner be emptied, in which case it shrivels and dries up. But on being put again into the water, it re-opens the closed apertures, again fills itself, and becomes round as before.

In my various excursions on the sea, I have observed that it contains many animals which, absorbing the water by their mouth, produce a small vertiginous current, that runs into it. The animal in question has not this power. The water enters it almost insensibly by occupying gradually the internal space which was empty. This I perceived

ceived by making use of the lens, but more distinctly by tingeing the sea-water with cochineal, as the animal will live several hours in this water without any apparent injury. The red particles of the tincture will then be seen slowly to enter the two apertures with the water, gradually filling the vacuity of the animal, without the appearance of a current of any kind. After some time the slow motion of the particles ceases; that is, when the internal cavity is completely filled with the coloured water, which I could cause to issue from the apertures at pleasure, by pressing the ascidia between my fingers.

If, when all the water is thus brought out of the ascidia, the animal be immersed in that contained in a vessel, in such a manner that only one of the apertures be under water, it will fill itself completely by that, whether it be the upper or the lower. It is evident from this, that there is a communication between the two apertures; of which I also had another proof equally demonstrative,

monstrative, in the air which issued from the lesser aperture, and which, by means of a small tube, I could, without force, cause to pass into the greater, and *vice versa*. When, besides, I kept one of the apertures closed while I blew into the other, the animal swelled like a bag, and the air found no vent.

It appears therefore certain, that the upper aperture is the mouth of the animal, and the lower the anus. In fact, by the latter I have frequently seen the ascidiæ discharge matters which had all the appearance of being excrementitious. This lower orifice, likewise, communicates with another channel, or organ, as we shall see presently.

Except slowly closing and opening these two apertures, this species of ascidia seems to have no kind of motion; not even when irritated by punctures, cutting, or any other violence.

The largest are more than two inches in length,

length, and above one in breadth. Their size is different according to their age, so that some very young ones are not more than two lines in length. They are all of a semi-transparent cinereous azure colour, somewhat resembling that of the common calcedony. The skin externally is rather smooth, but soon becomes rough from the numerous small sea-snails which fasten to the back and sides; a single ascidia frequently carrying on it a great number of other animals.

If this skin be cut longitudinally without injury to the internal part of the animal, it will be found resisting and coriaceous; and appear to be only a case which sheaths and defends the tender body of the ascidia. It is easy to detach it from the back, without lacerating it; since, except in the parts near the two apertures, where it adheres rather closely, it is almost loose.

In Fig. III. this coriaceous skin, cut longitudinally, is represented entire, and standing

ing upright, from its firmness and elasticity. Fig. IV. exhibits the animal deprived of this skin, in which appear the two obtuse beaks, and the two radiated apertures.

The animal, when thus naked, is tender, and almost gelatinous; but, which may excite surprise, even in this state it does not desist, when under water, from opening the apertures and filling itself with that fluid, when it is empty. Its colour is a delicate white, but, near the larger aperture, sprinkled with red spots. On holding it up to the light, we perceive two series of innumerable threads, the one running lengthwise, the other transversely; which threads may be rendered very visible, either by putting the animal into brandy, or by inflating it, and causing it to swell beyond its natural dimensions. (Fig. V.)

On examining these threads, I discovered that they were so many minute muscles, which, intersecting each other, formed quadrangular spaces in the middle; and were

designed by Nature, the longitudinal to shorten by their action the length of the body, and the transversal to contract the breadth. In fact this double motion, though small, is visible in the denudated ascidia; though it is not discernible when the animal is clothed in its coriaceous integument. Around the two apertures the threads or muscles have a circular direction to close them at the will of the animal. This is represented in Fig. V. In it likewise are expressed a number of black lines in directions entirely irregular, and which intersect, and form anastomoses in several points, such as we sometimes see in the branches of the *Iris nobilis* (the red coral). These represent small bands or fibres which intersect the two rows of muscles, and the use of which I have not been able to discover.

If the animal, when deprived of the coriaceous skin, be rendered shrivelled and lax by its water being exhausted, and then gently inflated with air; there will be discovered in its internal part a canal, shaped
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at the bottom like a pear, and corresponding to the lower part of the ascidia. This canal, as it ascends, becomes smaller, and, after having made two deflections, ends in the lower aperture. (Fig. VI. F. G. H.)

If this canal be lightly pressed at the base, or in the middle, there issues from the lower aperture, which is its orifice, a kind of granulated matter, which, viewed with the microscope, appears to be an aggregate of semitransparent vesicles, each including a central globule of a yellowish colour. Both the vesicles and globules are of so delicate a construction that they are dissolved and destroyed by the slightest touch (Fig. VII.) Except this canal, another which forms a communication between the two apertures, and which may be seen on opening the animal, and that double series of muscles enveloped in part by the irregular bands or fibres; all the rest of the animal appears so mucous and similar, that I was unable to discover any other viscus or characterized part of organization.

But

But what opinion shall we form of the globules contained in those transparent vesicles? That they are possibly eggs or small foetuses of this species of ascidia? Before I proceed to explain what I think, or rather what I conjecture, relative to them, we will turn our attention, for a moment, to the small ascidiæ which are frequently found adhering to the large ones. In Fig. I. and II. the references B. C. point out two of these small ones adhering to the larger ascidia, in the manner mentioned at the beginning of the chapter. The second (C) is attached to it entirely; the first (B) adheres in part to the marine concretion in which the mother-ascidia is planted. Both the small ones perfectly resemble the adult ascidiæ, not only in their apertures, but in the rest of the body, and the internal parts; containing even vesicles and globules, though smaller in proportion. There are also many as small as these, and indeed smaller, which are entirely solitary, and affixed to the sub-aqueous rocks. But I rather chose to confine my observations to those ascidiæ which

grow and develop themselves on the larger, in order to discover what connection the former have with the latter. I soon perceived that they have no internal communication, but that all their connection is in the coriaceous skin. This is evidently seen in Fig. III. representing the skin detached from the animal, with the smaller ascidia adhering to it as before, without the least injury or alteration. I found, likewise, that they might be separated from the larger ascidia, without hurting the coriaceous skin; and it is evident that they are only fastened, and as it were glued by a kind of viscous juice which always moistens these ascidia in their early age, and by means of which, as was before remarked, other minute animals are frequently stuck to them.

These observations prove that this species of ascidia is not generated in the same manner with the polypi of Trembley (*Hydra viridis, fusca, grisea*. Linn.) though at first view it might seem so to be from the smaller polypi pullulating on the larger. It

is well known that the former are a continuation of the body of the latter; which is not the case in these ascidia. I, however, incline to believe that these microscopic globules, contained in vesicles, are the eggs or rudiments of the animal; and that, on their issuing from the canal above described, they remain attached to the body of the mother-ascidia, where they develop and grow; and that they do the same on any other solid marine bodies on which they may chance to fall. This idea, however, I only offer as a conjecture, leaving to others who may be more fortunate in their enquiries to prove it true, or shew it to be an error.

On comparing this ascidia with the various species of that genus already described, that which seems to have the greatest resemblance to it is the *Tetbyum* of Bohadsch, which he has thus defined, "*Tetbyum coriaceum, asperum, coccineum, organorum orificiis setis exiguis munitis**." It was placed

* De quibusd. Animal. Marinis. Dresdæ 1767.

by Linnæus in the genus of *Ascidia*, with this definition—" *Ascidia scabra tuberculis coccineis*." But if this animal has some resemblance to mine, it differs, at the same time, in several specific characters. Omitting that the ascidia of Bohadsch is always much larger, that it is of a scarlet colour, and that the thin skin which invests it is rough and scabrous; it is to be observed, that the upper aperture resembles a cross, that the lower is of a triangular figure, and that the edges of both are furnished with minute bristles; all characters not found in that of which we treat.

It may be thus defined—*Ascidia coriacea lævis subdiaphana, apertura superiore octogona, humiliore heptagona.*

II. When coral is drawn up from the bottom of the sea, and immediately thrown into its native water, reserved in some vessel, we frequently find on its branches an animal which, from its strange and singular form, merits a moment's consideration. It

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is delineated in Plate X. Fig. VIII, except only that it is represented somewhat larger than life, to render it more distinct to the eye. The head (M.) is enlarged on both sides, and the mouth is placed in the under part of it. It has eleven lateral tentacula, five on the left, and six on the right side; nor must we imagine that the sixth tentaculum is wanting on the left side; since out of thirteen individuals that I examined, I did not find one of a different conformation. The two anterior tentacula (H. I.) the animal can at pleasure draw in, as snails do their antennæ, and conceal them in two hollow sheaths X. Z. It can also push them forth at pleasure. The other nine remain always in the same position, or that in which they are delineated, even when the animal moves. Seven of them are tridentated (O, R, T, V, L, Q, S,) and two quadridentated, (P. N.) The lower extremity of the animal terminates in a point (Y). When first taken out of the water the body is covered with a viscosity which attaches to the fingers, and forms small threads like those

caused by snails. The substance of the animal somewhat resembles flesh. It is of a cinereous yellowish colour. Along the back there is a streak of a lighter colour, which has a regular motion of contraction and dilatation; and which I suspect to be the heart, or some analogous organ, such as that which is observed in the back of caterpillars and various other insects. It does not swim, but crawls on the branches of coral, or other subaqueous body, after the manner of several other terrestrial and aquatic worms. The part under the body, which we may therefore call the feet, has a great analogy with the same part in snails. Though not formed to swim, it can rise to the surface of the water by inflating its body.

When taken out of the water it does not die very soon; but its death quickly follows when it is put into fresh water; as is the nature of many marine animals, to which, as I have repeatedly found, in many experiments, fresh water is a deadly poison, which even has the power, in some instances, of relaxing and destroy-

destroying their members in a few moments.

I am compelled to leave the history of this curious animal incomplete, since I had not time to make the observations on it that I could have wished. But in what genus of the class of vermes shall we place it? The mollusca which seem to have the greatest affinity with it are the limaces, and the dorides. But the characteristics of these two genera are not suitable to the present worm, as may be seen by consulting Linnæus. Shall we then consider it as constituting a new genus? I leave this question to be decided by such of my readers as are versed in this part of natural science; and proceed to describe another kind of animals which are very numerous at the bottom of the Strait of Messina.

III. It is known that the escharæ are thin crusts, having roots, and for the most part calcareous, formed of several rows of small cells, at the bottom of which are implanted very minute polypi, furnished with filament-

ous arms. These cells increase in number by new ones forming at their edges. Several authors, both ancient and modern, have written of these *escharæ*; and since Linnæus, this genus of lithophyta has been enlarged, with the addition of several new species, by M. Pallas; the greater part of which, however, have been described from the dead specimens of museums, and not from the living *escharæ* of the sea. Yet notwithstanding these discoveries, so abundant are these marine productions, that it will not be difficult to find some that have all the characters of novelty. Such, I flatter myself, is that which grows on corals and other productions, both animate and inanimate, of that part of the sea. At first it is a simple shoot, but afterwards multiplies and extends its branches, until it covers the bodies on which it has taken root. This *eschara* is represented in Plate X. Fig. IX. nearly in its earliest state, as seen through a microscope, when it begins to put forth its first shoots on a branch of coral. It is formed of small cells, somewhat flat and oval, membranoso-calcareous, each of which has in the
upper

upper part a round beak or mouth, with a longitudinal projection under it. I may say that this production was in part generated under my eyes, as I kept it in a small vessel full of sea-water, which I was careful frequently to change.

At first there was only the small trunk or stem A. D. formed of four cellules A, B, C, D, each containing its polypus. It afterwards grew upwards, and also shot out two lateral branches D O, E M. The polypi of the four lower cells died, and six others were produced; two at S, X, in the lengthened part of the trunk, and four, I, L, Z, V, in the two branches. I have observed in this *eschara*, and in several others, that it appears to be a constant law of nature, that the older cells shall lose their inhabitants, and the new ones acquire them; only that the latter have them not so soon, or at least they are not so soon perceivable in them. Thus, at the time the six polypi above mentioned appeared, they were not perceivable in the four upper cells O, H, P, M.

This eschara afterwards put forth other branches, which were followed by others, till it had produced a thick and crowded cluster of them. I have not given the figure of this cluster; that which I have given being, I doubt not, sufficient to assist the imagination of the reader to form an idea of it. This eschara is an extremely thin crust, and, being calcareous, the nitric acid, though diluted with water, dissolves it almost in an instant, with a sensible effervescence.

But let us turn our attention to the polypi, which form the most interesting part of this marine production.

If a piece of the eschara be put into the hollow of a watch-glass, with some seawater, and viewed with a microscope, taking care that the water be not shaken, the polypi will be seen to come out from their cellules, like minute cylinders, with their arms displayed at the top. Fig. IX. represents six of these polypi. The arms of every polypus are in number at least twelve, and form
a kind

a kind of inverted bell, which, by a continual agitation, produces a small vertiginous motion in the water, that causes it to run to the narrow part of the bell, where is the mouth of the animal, which receives the water, and the particles swimming in it, from which it may choose those proper for nourishment. A similar action, as I have frequently experienced, is exercised by innumerable other marine animals, which are destined by nature to remain fixed in the same place. As they are unable to go in quest of their necessary aliment; by means of their arms, or other analogous organs, they cause their prey to come to them.

If the water be shaken, by accident or purposely, the polypi immediately close their arms, retire into their cells, by a round orifice they have at the top, and there lie flat till the water is again at rest; when they again come out, put forth their arms, and cause the little whirlpool, as before. Frequently, likewise, they suddenly retire into their house, when the water, to all appearance, is calm.

The transparency of the cells enables us to view the polypi within them. They lie bent like a bow, with their arms grouped together, and are the more easily discernible, as their bodies have a slightly yellowish tinge. While they remain within the cell they may, likewise, sometimes, be observed to move. Though I have not been able to perceive with certainty that they are attached to the cell by the lower part of the body, I have little doubt but they are ; from that part of their body always remaining in contact with one point of the cell, whether the polypus comes out, retires into, or moves itself within, the cell.

After some days the polypi no more come out of their cells, but still continue to have motion ; and a longer time having elapsed, they cease to live, and their carcases may be seen in the cells half consumed. In the mean time, new cells shoot out, with new polypi, at first motionless, but which soon begin to move, and afterwards come out of their cells, and form, like the others, small vortices

vortices by the agitation of their arms. By inspecting Fig. IX. we may see that every new cell is attached to an old one a little above the aperture by which the polypus comes out; nor can I entertain the least doubt but the new cell and the polypus it contains derive their origin from a germ or rudiment proceeding from the old polypus, though these germs, from their extreme minuteness, are not discernible by the eye, even with the assistance of the lens.

This eschara may be thus characterised:
Eschara membranaceo-calcareo, ramosa cellulis ovatis subcompressis, facie una porosis, polypis retractilibus.

IV. The animal I shall next describe confirms a discovery I made in 1786, in the Strait of Constantinople, where, while prosecuting my enquiries relative to a variety of instructive objects, and particularly the nature and properties of the animals produced at the bottom of that sea, I discovered the circulation of the fluids in various polypi.

This

This circulation was seen by many intelligent persons, and among them by the Chevalier Zulian, the Venetian Ambassador at Constantinople, with whom I had the honour to reside, and who, as he himself possesses extensive learning, and liberally patronizes the sciences, gave me his assistance in my philosophical enquiries during my stay there.

The circulation of the fluids observed in several polypi of the Strait of Constantinople, is confirmed by a polypus found in the Strait of Messina. While fishing in this Strait, I found, among other substances, some leaves of marine plants, a fragment of one of which having a kind of down on its edge, attracted my attention. On putting it into a concave glass filled with sea-water, I discovered it to be a receptacle of polypi. They are represented as they appeared to the eye, and of the natural size, in Fig. X. in which A B. is the fragment of the marine plant, with the two sides covered with a multitude of minute polypi. We perceive that,

that, except the three branching ones, M, N, O, all the other polypi are single, and that every one is attached, by a long leg or stalk, to the fragment of the plant A-B.

But the form and organization of these minute animals cannot be conveniently observed without a lens of a considerable magnifying power. Fig. XI. represents one of them as it appears when viewed with a microscope while still attached to the marine plant. It appears, however, that this adhesion is not in consequence of small roots or fibres, but that the foot or stem is immediately fastened to the plant. This stem in the upper part enlarges into a pear-shaped body, R, E, M, S, which I shall call the bell, from the cavity or base of which, M, E, arises a somewhat flattened globule having in the centre an orifice N, which, as we shall soon see, is the mouth of the polypus. Under this globule, and at the base of the bell, issue the arms of the animal, which terminate in sharp points, and are fifteen in number, though in polypi of this

this species they are sometimes more and sometimes fewer.

These polypi can draw their arms and the globule into the bell, which they do when the water is shaken, or when they are touched; but the rest of the body and the stem are entirely without motion.

The arms, as they now appear, are in a state of rest and inaction; but the animal can at pleasure, like the polypi of the eschara, create in the water a small vortex running towards its mouth. To be convinced that the small aperture N is this organ, it is sufficient to place it in such a manner that the eye may look perpendicularly down it at the time the small whirlpool is in action. We then see that the polypus enlarges, contracts, shuts and opens it; and that the small particles brought by the vortex enter into it, and descend through a minute continued canal; as may be discerned much more distinctly if the water be tinged with any colour. In consequence, likewise,

of the different motions of the mouth, the small button or globule, in the top of which it is placed, assumes different forms.

The polypi represented in Fig. X. were the first I observed, but not the only ones, since I afterwards found many more of the same species on different branches of fucus. The largest were four lines in length, and the smallest half a line; but the latter, in water frequently renewed, soon grew to the size of the former. Their white colour renders them easily distinguishable by the eye from the bodies to which they are attached; and, when viewed through a lens, they are found to be transparent. This transparence enabled me to see the circulation of their fluids.

Along the foot or stem of every polypus (Fig. XI.) we see a small column or chain of particles which extend upwards to the extremity of the bell. At first, I thought that these atoms made a part of the organization of the animal; but I afterwards found
that

that they were not fixed but moveable, and designed for the same function with the red globules of the blood in animals of a superior order. The following is the method adopted by Nature in the motion of these minute particles. Every five or six minutes they ascended rapidly from the bottom of the stem, and penetrated longitudinally through the middle of the bell M, E, R, S. In the mean time, the number of them in the stem diminished, until, at length, very few remained there, the greater part having passed into the bell; where they were all in motion, producing a kind of effervescence, which continued some seconds. They afterwards returned, by the way they had ascended, to the lower extremity of the stem; where they remained at rest for a short interval; and during this interval it was that I first saw them, and took them for a solid part of the animal. They soon, however, resumed their former motion, ascending through the stem, and collecting in the bell; where the intestine ebullition again took place, till the current again descended

to

to the bottom of the stem, when the same alternation of rest and motion succeeded. Thus the mass of these particles moved regularly and constantly in the polypi, which it could not have done unless we suppose a canal or longitudinal vessel, though the transparency of the polypi prevented its cavity being discernible.

Among several dozens of these polypi, of different sizes, which I examined, there was not one that did not exhibit this species of circulation. This, when the animal was in full life and vigour, that is, when it was just taken out of the water, was extremely regular, and such as I have described it; but it altered, more or less, when the polypus began to suffer by being kept in water not frequently renewed. The motion of the particles then either ceased in the middle of their course, without recommencing; or, after an interval, began again with difficulty, and lasted only a short time; or, if it continued regularly, it was extremely slow. How much do these appearances of dis-

turbed functions correspond with those of a languid circulation, which I have observed and described in certain animals, both of a cold and warm temperature *! It is, however, to be observed, that this circulation was more distinctly visible when the polypi were viewed on one side, than when seen on the other; since, in the latter case, the alimentary canal which runs through the stem, being more or less filled with subtle matters taken in by the polypus, these matters somewhat obscure the view of the circulating particles in that place.

I had the curiosity to cut the stem of some of these polypi transversely, and to put others into fresh-water while alive; attentively observing the results. In the former case the particles, which here perform the office of blood, ceasing their periodical motion, issued from the incision, in the same

* *Fenomeni della Circolazione considerata nel giro universale del vasi*—The Phenomena of Circulation considered with respect to the whole circuit of the vessels.

manner as the blood flows from a vessel that is perforated or cut. In the latter, the circulation suddenly ceased, the arms became languid and faint, and the body of the polypus soon suffered dissolution.

I made another experiment, by putting them in sea-water of the temperature of 38° (118 of Fahr.), consequently in a heat much greater than that they experience in the sea. They all died almost instantly. But we must not be surprised at this, as the greater part of animals that live in the sea could not long have survived them in the same heat. These polypi, however, continued to live in water kept in vessels, when the temperature of the atmosphere was 21° (80° of Fahr.) though a much greater heat than that of the sea, in which they grow and multiply.

But what efficient principle is the cause of this circulation? What force determines the particles to move swiftly along the stem of the polypi and pass into the bell? and what

other force obliges them to take the opposite course? We cannot here have recourse to the idea of a heart, or any analogous organ, such as, for example, the great artery which runs just below the skin along the back of many insects and worms, which, by its systole, visibly impels the blood from the posterior to the anterior part of those animals; at least I never could discover any thing similar in the body of these polypi. We can only suppose, at the utmost, that the sides of the bell, distended more than usual by the influx of the particles, on restoring themselves by their elasticity, may compel the particles to return into the stem, where they find less resistance; and that the bottom of the stem being, in like manner, enlarged by the great quantity of these particles, may at length contract by its natural force, and drive them into the upper parts. But this hypothesis is not only unsupported by proof, but insufficient to explain the phenomena. From want of data, therefore, I am compelled to leave the problem unsolved.

It

It may, perhaps, be objected that the motion I have described in these polypi is not truly and rigorously a circulation, the particles continually passing and returning within the same vessel; whereas a real circulation supposes a double system of vessels, some of which convey the sanguineous fluid from the centre to the extremities of the body, while others reconduct it from those extremities to the centre.

I must observe, however, that this idea is derived from the animals we call perfect; but it does not hence follow that the circulation in the less perfect may not properly be called by the same name; in like manner as some viscera or organs retain their denomination, notwithstanding that, in their passage from the perfect to the less perfect animals, they may have lost some of their parts. Who is ignorant that the heart in the human species, quadrupeds, and birds, is furnished with two auricles and two ventricles? But shall we, therefore, not call this organ a heart in animals of the amphibious

bious class, and fishes, because in them it has only one auricle and one ventricle? Is not also the arterial vessel in several insects and worms, which continually contracts and expands, called a heart, by Linnæus and other naturalists of the first eminence, because it is designed by nature to perform the office of one? The same may be said of the lungs and *asperæ arteriæ*, which bear the same denominations in the lowest class of animals, notwithstanding they differ so widely in their structure and configuration from those of animals of the superior classes. The same is true of the circulation. In man, in quadrupeds, and birds, it may be said to be extremely operose: but descending in the scale of animality, it becomes less operose, the circuits it makes are shorter and less intricate, until at length it becomes extremely simple, the vital fluid going and returning in a single canal, as is observed in these polypi. Yet is it not on this account to be considered as having lost the character of a true circulation; since, in respect to the end designed, it is equally complete and perfect

perfect in these animals of the last order, as in those of the first? But of these different systems of circulation, it will be more opportune to treat in the Travels I propose to publish. The work I have before cited, if I am not mistaken, evinces how much I have studied this interesting part of physiological science, as it relates to terrestrial and amphibious animals: that I intend to lay before the public will contain a long chapter relative to this subject, with respect to marine animals.

I shall conclude my description of this polypus by remarking, that I think I am authorized to consider it as a new species; since it has not, to my knowledge, been described by any other writer. It may be thus characterized: *Polypus nudus, sæpius simplex, pedunculatus, affixus, corpore campanulato, cirrhis subulatis retractilibus, circulationem humorum exerens.*

V. We will now proceed to a fifth animal of the order of mollusca, found at the

bottom of the sea, which, though it be well known, deserves attention for the elucidation it affords of a question agitated among naturalists, and not yet completely determined. We know that the *echini marini*, or sea-urchins, are mollusca, armed with very thick spines; and it is also known, that they are provided with a prodigious quantity of small tentacula, which they put forth and conceal at pleasure: but which of these perform the office of feet, and enable these animals to move progressively, is not satisfactorily decided; some ascribing this motion to the action of the spines, and others to that of the tentacula.

Some years ago, I made a number of experiments in the Gulph of Spezia, with a view to elucidate this question; of which I gave some account in the Memoirs of the Societa Italiana *, reserving the details till I publish the observations I made in the Sea of Genoa. The sum of the principal results is as follows.

* Tom. ii. p. 2.

If the echini are taken out of the water, as they will live out of it a little time, the slow and short progressive motions they make are performed solely by means of their spines; but so long as they remain in their native element, their removal from place to place is effected entirely by their tentacula.

I took five *echini spatagi* which were brought up by the coral fishermen, and put them immediately into a bucket of seawater, in order to examine them on my return to Messina a few hours afterwards. By the way, I observed, that, notwithstanding the agitation of the water, caused by the motion of the bark, they had all five ascended from the bottom of the bucket up the sides, almost to the top, where they remained attached by means of their tentacula. I then perceived that the tentacula were not only of use to fasten these animals, but to enable them to remove from place to place; as the spines, from their rigidity, could not have contributed to their ascent. I detached them with some difficulty, and, to discover
the

the nature of the mechanism of their motion, placed them at the bottom of a glass vessel with smooth and perpendicular sides. I first directed my attention to one which I had laid in an inverted position, that is, with its mouth turned upwards; for, when in their natural state at the bottom of the sea, they always have that part downwards. This posture being a violent one, the animal endeavoured to turn himself. On one side he thrust out fifty or more tentacula, extending them as much as he could, and fixing them to the bottom of the vessel. He then contracted them, and by the contraction somewhat raised his body. He was now, as it were, on one side, and remained in that position, by holding fast with the contracted tentacula. He then put forth other tentacula on the same side, which he again fixed to the bottom, and contracting them, and detaching the others, made another part of a revolution with his body. When he had performed this curious operation three times more, his mouth, which before was placed upwards, became turned downwards, and he

thus

thus recovered his natural position. These motions therefore were effected by the tentacula, and the spines had no other part in it than by separating and giving the tentacula liberty to act.

The animal afterwards, by the same means, came under the sides of the vessel, which he ascended with considerable expedition quite to the top, so as to rise five or six lines above the surface of the water. In this ascent he only employed the tentacula by extending and contracting them as before.

In fact, I fully convinced myself that the spines had no kind of part in these motions, by cutting them off; since then the echini, when placed in an inverted position, could still turn themselves, and move in the same manner as before, either along the bottom, or up the sides of the glass, by the action of the tentacula.

I have said before, that these animals were detached with some difficulty from the sides
of

of the vessel. I wished to try what weight would be requisite to force them from the glass; and I made the trial with one of them, which had fastened to the top of the sides of the glass, and rose nearly half an inch above the surface of the water. I laid on his spines a piece of lead weighing thirty-two ounces; notwithstanding which he still held firm, and it was necessary to add seven more ounces to force him from his hold. It required therefore a weight of thirty-nine ounces to detach the tentacula from the glass.

But what shall we suppose to be the cause of so strong an adhesion to bodies of so great smoothness as glass? The following observations will elucidate this question.

If we view the tentacula through the sides of the glass-vessel at the time the echinus stretches them out, and before he fixes them, we shall find that they are of a white colour, that each of them terminates in a papilla perforated in the middle; and if we

cut the tentaculum off at the root, and view it with the microscope in a horizontal position, we shall perceive that this orifice is the extremity of a canal, which runs from the bottom to the top of the tentaculum, and enters into the body of the animal. If also we press the tentaculum with a small wire, or other instrument, a little drop of dense and extremely viscid liquor will issue from the orifice. With this gluten the echini, there can be no doubt, fasten themselves where they please. The transparency of the tentacula enabled me, with the assistance of a lens, to see, through the sides of the vessel, the means the echini employ to obtain so strong an adhesion. They apply to the sides the papilla of the tentaculum, and from that point expel the sea-water. The orifice of the papilla then enlarges and becomes deeper, forming a small cavity, which a moment after is filled with the glutinous matter, which fastens the tentaculum to the glass. The same takes place in every tentaculum; and thus the echini are as it were
bound

bound to the glass by so many small cords as there are tentacula which touch it.

Reaumur observed, that the patellæ (limpets), to detach themselves from the sub-aqueous rocks, to which they adhere tenaciously, throw out a kind of water which held them fastened. This water I never saw issue from the papilla of the tentaculum, though I used the strongest magnifiers. It appears to me, that the echini employ other means to free themselves with facility from their fastenings, which are, by shaking the tentaculum, and turning the papilla obliquely, in such a manner that the water enters between it and the glass, which in a moment dissolves the gluten.

We have thus shewn that the offices of the tentacula in these echini are two; one, to serve them as feet to remove from place to place; and the other, to hold them anchored where they choose at the bottom of the sea. Such a provision was very necessary

fary for the echini in every sea, to enable them to resist the fury of tempests, but especially for those of the Strait of Messina, which is so frequently liable to storms. Without it they must be the sport of the waves, and would be carried away and broken, from their extreme fragility.

It remained for me to make some experiments on them when kept out of the water. It is certain that then they never put out a single tentaculum; and that, therefore, if they have any progressive motion, it can only be performed by means of their spines. I placed two of them on a horizontal plane; at first with their mouths turned upwards, as I had done by the others. They immediately began to move their spines in every direction, endeavouring to recover their natural posture, but always in vain. Their fruitless attempts resembled those of the tortoise when laid on its back; and, like that animal, they removed a little from their place, though with much greater slowness. When they were turned with their mouths down-

wards,

wards, the spines under their bodies were in a slow, but almost continual, motion; by which means, with great difficulty, they changed their place, but made a very slow progress.

These observations relative to the echinus spatagus, which have not been before made, to my knowledge, on any species of this genus, agree, in all that is essential, with those I made on the echinus esculentus. From them it appears that those are in an error who suppose the spines the only instruments of motion in the echini; as also those who ascribe this office solely to the tentacula; since the motive principle is divided between them; but with this difference, that it resides in an infinitely less degree in the spines than in the tentacula.

I shall omit to notice the madrepores, cellularia and fertularia, which are brought up from the bottom of the same Strait, both because they are species already well known, and because I had not sufficient leisure to
examine

examine their polypi while employed in the observations I have already detailed. I have only mentioned these animated productions to signify that they are found in the Strait of Messina.

OF THE CORAL FISHERY IN THE STRAIT OF MESSINA.

This fishery is extremely laborious and dangerous. The description of the net used in this fishery is given in the preceding page. The Strait of Messina is a narrow passage between the Italian and Sicilian peninsulas. It is about 20 miles long and 1 mile wide. The current is very strong and runs from the Sicilian side to the Italian side. The fishery is carried on by means of a large net which is towed by a fleet of small boats. The fish are caught in the net and then taken to the shore where they are sold. The fishery is very important to the people of the Strait of Messina as it is their principal source of income.

C H A P. XXIX.

OF THE CORAL FISHERY IN THE STRAIT
OF MESSINA.

*This fishery extremely laborious and dangerous—Description of the net used in this fishery, and precautions necessary in throwing it into the sea—Parts of the Strait in which the coral is found—Different depths from which it is brought up—Situations in which it most abounds, and is fished up in greatest quantities—Comparison of this coral with that of Trapani and Barbary—Variety of its colours—Ten years requisite for it to attain maturity—Profit annually derived from it—These observations compared with others published by the Count Marfigli relative to this animal-plant—This comparison shews, First, that it is not always true, as the Count believed, that the situations proper for the growth of coral are those where the sea is calm :
Secondly,*

Secondly, that it will thrive at a greater depth than he has supposed : Thirdly, that it is not true that where coral grows most readily it scarcely reaches the height of half a foot in ten years : Fourthly, that it is not true that corals only grow in the roofs of caverns, and that their branches are always turned towards the centre of the earth : Fifthly, that the corals brought up in this fishery are not red only, but of other colours ; as, for instance, white ; notwithstanding the Bolognese naturalist was of a contrary opinion—In proof of this, a series of coralline branches of different colours, brought up in this Strait, are described—Proof that the white coral does not differ from the red, except in colour—The error of Marfigli that the polypi are flowers, has given occasion to the discovery of a truth equally unexpected and important—Probable opinion of the Messinese coral-fishers, that the immature coral has less consistence than the mature ; though it is not true, as the ancients believed, that corals while they remain in the sea are soft,

and harden when they come in contact with the air. In what sense we are to understand the observation of Donati, that the broken and detached branches of coral continue to live and multiply in the sea—The true generation of coral not unknown to the Messinese coral-fishers—Their opinion with respect to dead corals which are sometimes perforated by lithophagous worms.

THOUGH this narrow part of the sea is always more or less in a state of agitation, its bottom is, at every season of the year, searched for that valuable animal plant, the coral (*Isis nobilis*), provided the winds and current be not so violent as to endanger the barks of the coral-fishers. The latter are always mariners and fishermen of Messina, as it is necessary they should be both well acquainted with these seas, and have great bodily strength; this fishery, besides that it is frequently dangerous, being extremely laborious, since great exertions with the oar are necessary to resist a sea always in motion; and

and there are perhaps no people who endure the labour of the oar equal to the sailors of Messina.

The instrument they employ to tear from the rocks the branches of coral, does not differ essentially from that represented and described by Count Marigli, in his *History of the Sea**, and which is used, likewise, in other countries. It is formed with two poles of wood, crossing each other at right angles, and to the extremities of which, on the under side is fastened a piece of a net. A large stone is fastened where the poles cross each other, that it may the more readily sink to the bottom. A cord is strongly tied round the middle of it, one end of which the fisherman holds in his hand, and by it guides the net to those places where the coral is supposed to grow; and which is enclosed in the pieces of the net, broken off, and drawn up.

* Storia del Mare.

I have said that this coral net does not differ essentially from that described by Marfigli. It may not be improper, however, to observe, that the net of the Messinese fishermen is larger, and sunk with a greater weight. This is intended to prevent its being carried away by the violence of the current before it reaches the bottom. It is, besides, always thrown from the stern, and never from the sides; as represented in the figure given of it by Marfigli; perhaps on account of the danger that the weight of the net, concurring with the force of the current, should overturn the bark.

This fishery is carried on from the entrance of the Faro, to the part of the Strait opposite the church of the Grotto (*Chiesa della Grotta*); that is, through a tract six miles in length, and to the distance of three miles from Messina. Beyond these limits they never fish; either because there are no rocks on which the coral grows, or because they lie so deep as not to be reached by the net; or, perhaps, because

because the violence of the current prevents the barks from continuing there a sufficient time *.

Within these six years, indeed, two rocks have been discovered eight miles to the south of that city in front of the channel of San Stefano, which bear excellent coral in great abundance. Except the Strait, this fishery is now carried on in no other place.

The rocks which produce the coral are situated almost in the middle of the Strait, at different depths, from three hundred and fifty feet to six hundred and fifty. This depth increases as we approach the mouth of the Strait, where there is no longer any fishing; the rocks there, according to the coral-fishers, being a thousand feet deep.

* I was told by an old sailor, that there was once a fishery for coral between Stromboli and Cape Vatican; but that it was abandoned because it was extremely dangerous for the barks, which had no shelter from the wind when it blew from the west, north-west, or south-west.

The hollows and caverns of the rocks are the places from which they endeavour to bring up the coral with their nets; not but it likewise grows out of these, and on the sides of the rocks; but usually in less quantity. It is a constant observation, that every branch is perpendicular to the plain on which it grows, without ever turning on one side.

Coral grows more plentifully in places situated to the east than in those to the south; it is rarely found to the west, and never to the north. In the first situation, therefore, it is larger, and of a finer colour than in the second and third; which two valuable qualities are likewise found in that which is brought up from a less depth, compared with that which grew at a greater. The greatest height to which it grows is never a foot, and its usual thickness that of the little finger, and somewhat less than that of the coral of the coasts of Trapani and Barbary; but the latter are exceeded by the Messinese in vividness of colour. These differences, according

to the account of the fishermen, arise from their coral being produced in a sea which is kept in continual motion, from the surface to the bottom, by the current and the winds.

With respect to colour, there are three kinds; the red, the vermilion, and the white coral. The first is subdivided into the deep crimson red, and the lighter red. The vermilion is extremely rare, but the white common. In the white they include the clear white and the dull white.

The coral fishermen have divided the whole tract in which they fish into ten parts. Every year they fish only in one of these parts, and do not fish in it again till ten years are elapsed. This interval of ten years they think necessary for the coral to acquire its full growth in height and consistence. When they transgress this law, they find, in fact, the coral smaller, and of less consistence, and the intensity of the colour is always in proportion to the number of years they have desisted from fishing. When the ten years

have elapsed, they believe that the coral no more increases in height, but only in thickness, which, however, has its limits. In fact, they have observed that the coral fished up near San Stefano, a place where none had been sought for in the memory of man, though it was of a very bright colour, was not higher than the ordinary coral, though it exceeded it by one third in thickness.

The number of ships which usually go together in this fishery is eighteen or twenty, each of which is usually managed by eight men. The quantity of coral procured may amount every year to twelve Sicilian quintals. The quintal, as is well known, contains two hundred and fifty pounds, and the pound twelve ounces. The gain acquired is therefore adequate to the labour; yet may the fishery be considered as a secondary occupation, since the fishermen only follow it when they have no other employment by which they can make a greater profit.

It is evident that the account I have here
given

given can be derived from no more certain source than the relation of the fishermen themselves. I was desirous to be present at a fishing, and one was undertaken expressly to gratify my curiosity. As the branches of coral were taken out of the nets, I put them into glass vessels filled with sea-water. It is well known that, in this case, the white polypi will come out of their cells in the coral as soon as the water is perfectly at rest. I examined and re-examined these polypi, as it was the first time I had seen them; but I discovered nothing which can make any addition to the accurate observations of Peyssonel, Jussieu, Guettard, Donati, and the very recent remarks of the celebrated Cavolini, which seem to leave nothing to be desired to complete our knowledge of these animalcula, and their natural habits. But the observations I have already given above, enable me to add to, and, in part, to correct those of our illustrious naturalist Count Ferdinando Marsigli, relative to the present subject.

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The situations, according to him, favourable to the vegetation of coral, are those in which the sea is as calm as a pond; and it is found in greater abundance if they are exposed to the south, in less if they front the west, and totally fails if they have a northern aspect.

As to the first of these observations, it has already been seen that it is not always true: coral growing, and coming to perfection, in a sea constantly disturbed and agitated, as is that of the Strait of Messina; except only that it does not acquire that degree of extension it attains to in other places.

The second observation agrees with the remark of the fishermen of Messina, except that the latter affirm the eastern aspect to be more favourable than any other to the growth of coral; while in the maritime places examined by Marfigli it was found in greatest quantities to the south.

He asserts that the least depth at which coral grows is ten feet, and the greatest seven hundred and fifty; but that it is most usually brought up from between the depths of sixty and one hundred and twenty-five feet.

We have already said, that the depth from which the coral is fished up near Messina is from three hundred and fifty feet to six hundred and fifty; not that coral cannot grow at a less depth than three hundred and fifty feet, but because this is the least depth of these rocks. It is probable also, that it grows at a still greater depth than six hundred and fifty feet; but it being extremely laborious and fatiguing to fish at so great a depth, the mariners do not attempt it. Their observations, therefore, do not clash with those of Marigli, relative to the greatest and least depth at which coral is found; but they disagree with respect to the depth between sixty and one hundred and twenty-five feet, in which we are told by Marigli coral most usually grows, as it is found

found in equal plenty in much greater depths, that is, from three hundred and fifty to six hundred and fifty feet.

The fishermen from whom the above-cited naturalist received his information, were of opinion, that, in the situations most favourable to its growth, it scarcely, in ten years, attains to the height of half a foot.

Their assertion is probably supported by some fact, and I therefore shall not pretend to doubt it; but I must say that it cannot be considered as universally true, as the corals of Messina in that time attain their greatest height, which is nearly a foot. This is sufficiently corroborated by the corals of San Stefano, where, as that part of the Strait had never been fished, they have had sufficient time to arrive at their complete natural maturity. They are there thicker, but not higher, than the corals obtained, after the expiration of the ten years allowed, from the rocks where the fishery has been carried on from time immemorial.

Marigli

Marfigli tells us that corals are produced and grow only in the roofs of submarine caverns, and that their branches are always turned towards the centre of the earth.

That coral grows from the roofs of sub-aqueous caverns, and in an inverted position, is frequently observed; but we likewise know that it grows out of such caverns; and fixes itself in any place, either to stones at the bottom of the sea, the abandoned remains of shell-fish, or any other solid body; and then it has never an inverted position. In the different draughts made by the fishermen while I accompanied them, their nets frequently brought up the shells of dead oysters and other shell-fish, to which small branches of coral adhered. It is only a few years since a broken earthen vessel was brought up in their net, the internal surface of which was covered with branches of coral, with their tops directed towards the orifice, through which a part of them issued. When speaking of the coral fishery carried on round Lipari, I have said that, under the castle, a
 branch

branch of coral was fished up which grew on a piece of volcanic enamel*.

These facts not only prove that coral grows out of these marine caverns, but also that its branches very frequently grow upwards.

According to the observations of Marfigli, the natural colour of coral is between a deep red and a light carnation; recent coral of a white colour, or that of milk, he adds, he never saw. He tells us, however, that red colour, if the coral be boiled in wax or milk, becomes white. M. Pallas writes, that he had seen in the British Museum a large branch of coral of the colour of milk, and another of a vivid flesh-colour; but he will not warrant that those colours were natural†.

The coral-fishermen of Messina teach us that the assertions of the Italian naturalist,

* See Chap. XXIV. † Elem. Zoophyt.

and the doubts of the Academician of Peters-
burg are alike without foundation. In the
Strait of Messina they frequently find white
as well as red coral. While I accompanied
them when fishing, all the coral they drew
up was red ; but, before I left Messina, my
learned friend, the Abbate Grano, knowing
how much I wished to procure some
branches of white coral, obligingly presented
me with a series of coralline branches, of
different colours, from those which are more
or less red to a dark ash-colour, and from
that to a clear white. Of these branches,
which now make a valuable addition to the
class of Zoophyta in the Imperial Museum
at Pavia, I shall proceed to describe the
principal.

I. The bark of this branch has the colour
of sealing-wax ; but the solid coral is purple,
with some transparency at the extremity of
the branches.

II. The bark in colour resembles that of
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the foregoing; but the included solid coral is of a less vivid red.

III. The bark is of a blueish grey; the solid coral grey, with a slightly reddish tinge.

IV. In this specimen four branches shoot from the same stem; two of a pale red in the bark, and a whitish red in the solid coral. In the fourth the bark is of a whitish colour, and the solid coral still whiter.

V. Three branches joining in one, the colour of which, both in the bark and the solid coral, is a milky white.

Besides these cursory observations on the colour, I shall likewise make a few others on the structure of the cortical and solid parts of the white corals. They are invested with a white and friable bark, which may be scraped with the nail, and which, in

in some corals, where it is in best preservation, rises in conical tumors, open at the top with an octoradiated orifice, the mouth of the cellules which were once the habitations of the polypi.

The internal substance of the coral, which may be called the skeleton or bone of the animal, is sulcated on the surface with thin longitudinal striæ, has the solidity of hard stone, and, when broken transversely, appears lamellar. The nitric acid decomposes and entirely dissolves it, with a strong effervescence as if it were a calcareous carbonate.

These observations on the white coral prove its perfect resemblance to the red: or, to speak more properly, its identity with it; as no other difference is discoverable between them but the accidental one of colour.

The orifices of the cells in the bark of the white coral being octoradiated like those in the red, appears to be a proof that the

polypi in both are of the same structure, and, consequently, of the same species; the polypi inhabiting the red coral having likewise eight tentacula.

I have not made these remarks to depreciate what has been written by this celebrated Italian on the subject of coral. Notwithstanding the egregious error he has committed in taking the polypi of the coral to be flowers, supposing with the generality of botanists that it was a plant; his observations on the whole deserve great praise.

That coral is soft in the sea, but hardens when it comes in contact with the air, was the opinion of the ancients; but has been proved false by the observations of the moderns. The coral-fishermen of Messina, who derive all their knowledge from experience only, are convinced this opinion is erroneous; but they assert that coral which has not attained maturity has not that degree of consistence it acquires when it has arrived

arrived at its full growth. The truth of this position I was not able to ascertain, as, for that purpose, it would have been necessary to cast the net in one of those ten parts of the Strait in which it is prohibited by the law to fish till the expiration of the ten years prescribed. Yet the rules of analogy derived from what is observed in all animals and vegetables, incline me to favour this opinion.

The coral-fishermen who were consulted by Marfigli, and those of Messina from whom I derived my information, both agreed that the deeper we descend into the sea, the smaller is the coral; and some years ago I made enquiry relative to this subject of some other fishermen, who go to fish for coral on the coasts of Barbary, and near Sardinia and Corsica; and they likewise confirmed the assertion. This observation, therefore, appears to be universal and constant. But to what are we to attribute this difference? Were coral brought up only from places to which the heat, or

at least the light, of the sun can penetrate, we might suspect that one or the other of these two principles might more or less influence its growth. But it appears certain that corals grow even in those bottoms to which not an atom of solar heat, much less light, can penetrate; if the calculations of a celebrated philosopher are accurate, who asserts that the light of the sun does not enter deeper into the water of the sea than six hundred feet, and that his heat does not reach to a quarter of that depth. Yet coral is fitted up, according to the observations of Marfigny, from the depth of seven hundred and fifty feet. If we reject, then, these two principles as insufficient, it will be very difficult to discover what other can cause the greater growth of coral at a less depth.

I have sometimes thought that the pressure of the water at these great depths might possibly be an impediment to its development. But this idea by no means accords with the birth and growth of numerous minute plants and worms not at all inferior in

the

the delicacy and tenderness of their bodies to the polypi of coral.

Donati observes, that the broken and detached branches of coral will continue to live and multiply within the sea. This I do not hesitate to believe, provided they meet with a firm point of support to which they can attach themselves with their viscous humour. Otherwise, if they fall on the moveable sand, they become the sport of the waves, and I cannot doubt but they must perish. Such was the case, I am of opinion, with two branches deprived of their bark, and consequently dead, which were fished up when I was present. I was likewise confirmed in this opinion by the coral-fishermen, who told me that they had frequently drawn up from the bottom of the sea coral growing and alive, but always attached by its trunk to a shell-fish, a stone, or a fragment of an earthen vessel, but never to pure sand. I perceived, likewise, with some degree of pleasure, in the course of these conversations with the coral-fishermen, that they were not

unacquainted with the true generation of coral; as they told me that they had frequently observed, on hard matters drawn from the bottom of the sea, the first principles of coral beginning to germinate; which they describe as having the appearance of a red spot, with a button or bud implanted in those matters, sometimes tender and fragile, and sometimes hardened, and of the colour and nature of ordinary coral.

They were likewise acquainted with those branches of coral which, when fished up, are sometimes found perforated by lithophagous worms, and which are mentioned by Vitaliani and Marfigli. Their nets had frequently brought them up, either from the bottom of the sea, from caverns, or the sides of rocks; and these perforated corals were found sometimes broken in the trunk, where the perforations are most frequent; and at other times attached to some body which served them as a base. They were of opinion that these corals were thus perforated, because they were dry; and this dryness, they

they imagine, proceeds either from age, or their having been broken from their root by some fish, or by a part of a rock falling on them; or possibly by the coral nets, which do not always bring up all the branches of coral they tear away from their roots.

CHAPTER XXX.
 OF THE FISHERY OF THE SWORD-FISH,
 IN THE SAME STRAIT.

Two methods of taking the sword-fish: with the lance, and the net called palimadara—At what time the lance is made use of—Periodical passage of this fish through the Strait, sometimes on the coast of Calabria, and sometimes on that of Sicily, according to the difference of the seasons—It appears certain that this fish propagates in the Sicilian and Genoese seas—The lance only used for sword-fishes of a large size—Those of every size taken with the palimadara—Great destruction made of fish in general by this net, from its taking those which are very small—A similar destruction occasioned in the Sea of Genoa by the fishery with the bilancelle—Singular kind of bark for throwing the lance, and carrying the apparatus necessary

necessary for taking the sword-fish—Manner in which the fishermen discover and take it—Usual weight of the fish of this species taken in the Strait of Messina.

I PRESUME it will not be unacceptable to my readers to peruse a brief account of two other fisheries which are carried on in the same sea with that for coral which I have just described. One of these is for the sword-fish; and the other for the sea-dog (or shark). They will form the subject of the present and following chapter.

The sword-fish (*Xiphias Ensis* Linn.) is taken by the Messinese sailors in two ways; that is, with the lance, and with the *palimadara*, a kind of net with very close meshes. This fishery begins about the middle of April, and continues till the middle of September. From the middle of April to the end of June it is carried on upon the coast of Calabria; and from the end of June to the middle of September on that

that of Sicily. The reason of this is that, by the account of all the fishermen, the sword-fish, from April till June, entering by the Faro, coasts the shore of Calabria without approaching that of Sicily; and passes the contrary way from the end of July to the middle of September. We know not whether it takes this contrary route for the sake of food, or from any other cause; or whether it be the same fish which thus passes and repasses: it is only certain that it does not coast the shore of Sicily but when it goes to spawn, when the males may be seen swimming after the females, one of which is frequently accompanied by several males. At this time the fishermen, likewise, have the most favourable opportunity for taking a double booty; as, when the female is killed, the males will never leave her, and are consequently easily taken.

It seems almost certain that the sword-fish propagate their species in the Sicilian Seas, and also on the Coast of Genoa. They are every year taken in the Strait of Messina,
from

from November to the beginning of March, of the weight of from one pound to twelve; and at the latter end of autumn, and in winter, I have seen small sword-fish sold at Genoa which were taken in the neighbouring sea.

It is true that, in the Strait of Messina, sword-fish of so small a size were not formerly taken; not, I am persuaded, because they did not pass the Strait, but because the instruments for fishing which have been in use of late years were not then invented; especially the palimadara. This is a net eighty feet or more in length, and fifteen in breadth, made with strong cords and close meshes, so as to take fish of every size; whereas with the lance, which was formerly the only instrument employed in this fishery, the largest alone, which rise to the surface, can be taken. And this probably is the reason why the quantity of large sword-fish taken with the lance has of late years diminished; this premature fishery having destroyed prodigious numbers of these fish, and at the same time prevented their reproduction.

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A similar wanton and wasteful destruction of fish I have noticed in other parts of the Mediterranean, and especially near Portovenere, on the Genoese coast; where they fish with the *bilancelle*. By this name are called two vessels with a large lateen sail, placed opposite to each other at some distance, to which is fastened by two large cables a net of prodigious extent, which reaches to the bottom of the sea, and having very fine meshes, confines within it fish of every size, when it is drawn along by the motion of the vessels impelled by the wind; for without wind this method of fishing cannot be attempted. When during the summer vacation in 1783 I employed myself in the vicinity of Portovenere in making researches into the nature and properties of various marine animals which are indigenous in that sea, the result of which enquiries I afterwards published in the Transactions of the *Società Italiana*; I went with the vessels employed in this mode of fishing ten or twelve times, it being particularly adapted to the object I had in view; and I observed that,

besides

besides fishes of a large or a middling size, an immense number of extremely small ones were taken, which, being of no value, were again thrown into the sea, but not till they were dead, and almost torn to pieces by the rubbing of the net; and I could not avoid reflecting on the serious injury done to every kind of fishery by the destruction of such prodigious quantities of fish before they arrived at maturity. It is true, I was told there was a law at Genoa which prohibits the use, or rather the abuse, of the bilancelle. This, however, appears scarcely credible, when we see every year, in the summer time, three or four pairs of these vessels sail out to sea, in the Gulph of Spezia, to engage in this kind of fishing. The magistracy of the place, besides, whose duty it is to prevent the sailors from engaging in this injurious fishery, may be easily gained over to connive at it, for a sum of money, especially if the largest fish are every day sent to them, to prevent the vessels from sinking by being overladen.

When I arrived at Messina, the palimadara was not made use of, and the fishery for the

sword-fish with the lance was nearly at an
 end. For the latter mode of fishing the
 mariners make use of a kind of vessel they
 call *luntre*, which is eighteen feet long by
 eight wide. The prow is wider than the
 stern, in order to give more room to the man
 who throws the lance. In the middle is
 fixed an upright pole seventeen feet high,
 with ladders to go up it, and a kind
 of round platform at the top, for one
 of the crew, who acts as sentinel, to stand
 on. This platform is called *fariere*. Near
 the bottom this pole is crossed at right
 angles by another, ten feet long, the ex-
 tremities of which reach a foot and a half
 beyond the sides. To the ends of this pole
 or beam are fastened two oars, each twenty
 feet long. These oars are managed by two
 sailors, while a third stands in the middle,
 holding the right oar in his right hand, and
 the left in his left; who acts as pilot, and
 directs the vessel sometimes to this side
 and sometimes to the other. This part is
 performed by the same sailor who from
 the *fariere*, or round top, first discovered the

the sword-fish, observed its course, and pointed it out to the rowers; for, besides the two already mentioned, who row alternately, according to the impulse or directions of the third, there are two others, who, with smaller oars, row continually at the stern, following the fish, which makes a thousand turnings and windings, and seems to wish to play with the vessel as it sails. The lance used to strike the fish, is made of the wood of the lime-tree, which does not easily bend. It is full twelve feet long. The iron head affixed to it, which the sailors call *freccia*, is seven inches long, and has on each side two pieces of iron called ears, equally sharp and cutting, but moveable. These are united to the principal iron till the lance is thrown; when they fly open, make the wound larger, and fix the iron head more firmly in the body of the fish. The iron head is not fastened immoveably to the wood, but fixed in such a manner, that when the stroke is made it buries itself in the body of the fish, and is detached from the wood, but so that both the wood and the head re-

main fastened to a rope which is held firmly by one of the sailors, while the wounded fish is dragged after the vessel. This rope is of the thickness of the little finger, and six hundred feet long.

This apparatus, however, is not sufficient. When the sword-fish coast the shore of Calabria, two other men are placed to watch on the rocks and cliffs which rise out of the sea. A similar practice is necessary when the fish come down the coast of Sicily ; but there, as there are no rocks, these sentinels take their station on masts eighty feet high, erected in vessels of the largest size, anchored near the shore, and about a stone's throw distant from each other.

The manner in which this fishery is conducted is as follows : When the two men who watch on the rocks or masts of the vessels see the fish approaching, which, as they say, they perceive by the change of colour in the water, they signify it by shouts to the crew of the fishing vessel, which immediately

diately bears down and is directed by the shouts and signals of these men, till the man on the round top has discovered, and follows them with his eye. By his directions the vessel is tacked to one side or the other, while the man who is to throw the lance stands ready in the prow, till they come up with the fish; when the other comes down from the round-top, and, placing himself between the long oars, guides the vessel according to the signals or directions of the lancer, who, having found a favourable opportunity, strikes the fish, sometimes at the distance of ten feet, immediately lets go the rope he holds in his hand to give the fish scope to run, or, as they term it, *calma*. The men then row with all their might; following the course of the wounded fish, till he grows faint and is nearly dead, which they know by his coming up to the surface of the water. They then approach him, drag him with an iron hook into the boat, and carry him to land.

Sometimes the fish, enraged by the wound

he has received, turns upon the vessel, and endeavours to pierce it with his sword; and when the fish is of considerable size and strength, the fishermen are obliged to be very careful of this, as several serious accidents have happened from such attacks.

Sometimes the wounded fish escapes, either because the lance has not penetrated deep enough, or because, the rope breaking, he has carried it away infixed in his body. When the wound is slight, it soon heals; many fish having been taken with more than one scar; but if it be deep, he inevitably dies, and becomes the prey either of other fish, or the first fisherman who meets with him. The usual weight of the sword-fish is from one hundred to two hundred pounds; but some have been taken which have weighed three hundred.

CHAP. XXXI.

FISHERY OF THE SEA-DOG (A SPECIES OF SHARK) IN THE SAME STRAIT.

Different species of squali (or sharks).—This fishery dangerous from the large sharks which sometimes frequent this Strait, especially the formidable squalus carcharias (the white shark)—Accidents which have happened by their voracity within the harbour of Messina, and in several parts of the Mediterranean—Enormous opening of the mouth of the larger shark, sufficient to swallow a whole man—Entire bodies of men sometimes found in their stomachs—Parts of a large shark sent to the author after his return from the Strait of Messina—Its characters, taken from the exterior habit of the body—Several rows of teeth, and their configuration—These characters agree in part, but not entirely, with those

of the *Squalus maximus*, described by naturalists; whence it seems probable that this is of a different species, and not described by others—Resemblance between the position of its teeth and that of the teeth of the *Squalus carcharias*—Opinion of Steno, that many of the teeth of sharks are of no use, proved false by Herissant—Observations of the author on the same subject—The size of sharks formerly considerably greater than that of those taken at present; as is proved by comparison of the fossil teeth of the former with the natural teeth of the latter—Fossil bones of animals of other kinds, when compared with the natural, exhibit the same disproportion—Some change in the configuration of the teeth of sharks, and an increase in their number, as the age of the fish increases—A reserve of teeth within their jaw to supply the place of such as are lost naturally or by violence—This provision not found in the Messinese shark, though its teeth in other respects resemble those of other sharks—Singular structure of the teeth in another species of shark,

shark, and prodigious opening of the mouth—*This, likewise, had not the teeth in reserve which sharks commonly have, though it appears very probable that it once had them—Apparent inutility of several rows of teeth in this fish, and in the Messinese shark, as they remain buried in the fungous flesh of the jaw—Further examination necessary before we decide on this supposed inutility—The argument from analogy, even when it seems most conclusive, may lead us into an error—Reasons for denominating the above-described squali (sharks), fishes, though that genus is placed in the class of amphibia by Linnæus.*

WE shall proceed to treat of the fishery carried on in the same Strait for the sea-dog, a fish appertaining to the genus of *Squali* (sharks). The taking of this fish is accidental and not constant, as they have no periodical and fixed times of passage, are not very fit to be eaten, their flesh being extremely hard, and the fishing for them being not a little dangerous, on account of

the larger species of sharks, which will furiously attack men, and come up into the harbour of Messina. I was told by the people there that it was not long since a fisherman, while swimming, had his leg bitten off by one of these fish, which being afterwards killed near the light-house, the leg was found entire as he had swallowed it in his stomach.

This fact will not greatly excite the admiration of those who are acquainted with the voracity of these sea-monsters. Such accidents are by no means unfrequent in several other parts of the Mediterranean. A few years since two persons, who had gone into the sea to bathe near Nervi and Chiavara, on the eastern coast of Genoa, were killed, and almost devoured by these sharks. When I passed through Nice in the year 1783, I was presented with the jaws of one of these fishes, in the stomach of which the body of a child was found entire, as the whole city was ready to certify. I still preserve these jaws, which have the
teeth

teeth in them; and the width to which they open is such, that there can be no cause to doubt, for a moment, the truth of the fact asserted. Nicholas Steno, in his anatomy of the head of one of these sharks, taken a few miles from Leghorn, observes that the transversal diameter of the mouth, from one angle of the jaw to the other, was a Florentine ell; and that the other diameter, perpendicular to the former, contained four fifths of that ell. It cannot therefore be considered as wonderful that the bodies of men should be found entire in the stomachs of these fish, as the opening of the mouth in that he observed was sufficiently wide to receive them *.

In fact, besides the melancholy accident which happened near Nice, we have an account still more memorable given us by M. Brunnich in his *Ichthyologia Massiliensis*. I shall here give his own words; his relation being so circumstantial that, however

* Elem. Myol.

extraordinary

extraordinary it may appear, it cannot be doubted.

“ Capiebatur tempore quo Massiliæ fui,
 “ piscis ejus speciei (squalus carcharias)
 “ quindecim pedum longitudine. Major
 “ duos abhinc annos occidebatur hærens in
 “ littore urbes inter *Cassidem* et *La Ciotat*.
 “ Ventriculo tenuit duos scombros thynnos,
 “ parum læsos, hominemque integrum cum
 “ vestitu omnino intactum; omnes, ut ap-
 “ paruit, breve ante tempus devoratos.
 “ Testes oculati, inter multos alios fuere
 “ Dominus Garnier Secretarius Regis Gal-
 “ liæ, qui præclara corallii rubri fabrica
 “ urbis *Cassidis* pauperes sublevat multos;
 “ ut et Rev. Dominus Boyer Parochus urbis
 “ *La Ciotat* dictæ; uterque eruditione simul
 “ ac fide fatis pollentes *.”

“ A fish of this species (the shark) was
 “ taken, while I was at Marseilles, which
 “ was fifteen feet long; and two years

* Ichthyol. Mass. p. 5, 6.

" before a much larger was killed near the
 " shore between the towns of Cassis and la
 " Ciotat. The latter had in its stomach
 " two tunnies, little injured, and a whole
 " man, with all his clothes, untouched ;
 " which seemed to have been devoured but
 " a short time before. Among many other
 " eye-witnesses of this fact were M. Gar-
 " nier Secretary to the King of France, who
 " gives employment to so many poor per-
 " sons in his manufactory for working red
 " coral in the town of Cassis, and the
 " reverend M. Boyer, Curate of the town of
 " La Ciotat ; both eminent for their learn-
 " ing, and of unimpeached veracity."

This amplitude of mouth and throat, in
 the shark, besides what it is naturally, is
 enlarged by the great elasticity of the man-
 dibular bones, which are of a cartilaginous
 nature. Thus serpents can swallow animals
 more bulky than themselves, by consider-
 ably dilating their jaws and throat ; and a
 viper will gorge a rat that is twice as
 thick as itself.

When

When I was at Messina I had not the satisfaction to see any of these sea-dogs taken. But after my return to Pavia, the Abbate Grano was so obliging as to send me the bones and skin of one which was taken in that Strait; and which in some of its characters approached very near to the *Squalus maximus* of Linnæus, though in others it was essentially different. As I do not know that this fish has ever before been described, I shall give some description of it; principally directing my attention to the different rows of teeth it has, their configuration, and respective position in the jaw; and to some other circumstances which I think most proper to fix the characters, and enable us to compare this fish with any other of a different species in the same genus.

The body, which is somewhat flat on the back, if measured from the point of the snout to the root of the tail, is eight feet nine inches long; and in its greatest breadth five feet one inch and a half. The snout

or

or beak is pointed, the head round, the transversal diameter of the open mouth, which is placed under the snout, seven inches and a half, and the perpendicular seven inches. The upper jaw is longer than the under. Both are rounded in the middle, but the former less than the latter.

Between the point of the snout and the eyes are two holes imperfectly rectangular; the larger side of which is horizontal, and seven lines long; and the less, which is vertical, three lines long. These two holes pass through the skin of the fish from side to side.

The eyes, which are rather large, are situated on the two sides of the head. The spiracles, which are five, on each side, in the region of the neck, not very near to each other, are proportionate in size to the bulk of the shark, and increase in length as they approach the head. The anterior dorsal fin, which begins somewhat below the half of the body, is three inches long,
round

round at the extremity, and joined to a lanceolated appendage towards the tail.

Each of the two pectoral fins lies horizontally, is two feet long and one broad; and both have their origin immediately under the last spiracle, or that most distant from the head.

The ventral fins are each two inches in length; lanceolated at the top, with an appendage towards the tail. The anal fin is round at the extremity, two inches long, and situated a little below the region of the posterior dorsal fin.

The tail is bilobed, or, more properly, bicuspidated; formed of two fins, semicircular within, and which terminate in a point. The upper fin is twenty-two inches in length.

The colour of the body is dark grey; but lighter on the under part.

The

The number of teeth in the lower jaw is sixty-four ; there is, however, in the middle of it an empty space above an inch broad. The teeth form separated groups, and the direction of the groups is transversal, or from the outer to the inner part of the mouth. Every group is composed of four rows of teeth, except four of these groups, on the two sides nearest the vacuity abovementioned, and which contain five rows. These teeth, which on account of their being in separate groups are not contiguous, are extremely white, a little curved, with the points more or less inclined towards the gullet. The side next the outer part of the mouth is slightly convex, and the opposite side considerably more. The edges are angular and very cutting, but not serrated, and their points are very sharp. The smaller teeth are placed in the root of the jaw ; and are four lines long, and three and a half broad at the base ; but, as they approach the middle, they become larger ; and the largest are fifteen lines long, and seven and a half broad.

What

What has been said of the groups, number, form, and size of the teeth in the lower jaw applies equally to those of the upper; only that here we do not find the four groups with five rows of teeth; every group containing four, and not more. These teeth, besides, are straight and not curved; or, if they have any curvature, it is extremely small.

Some teeth of the first row, in both jaws, are broken; probably, in combats with other fish, or in seizing their prey. None of them are in sockets; but they are all planted in the jaw, within a hard and fungous flesh. It is to be observed that the first row projects out of the mouth, and is almost vertical to the plane of the jaw; but the other rows are nearly horizontal to this plane, having their points turned towards the gullet, and entirely or in part buried in the fungous flesh, which, when I prepared the shark for the Museum, I removed so as to shew the teeth below it. I shall add, that in both jaws some teeth of the last row were, at the base, still soft and

semi-cartilaginous ; and the internal cavity was full of a whitish and very soft substance.

To ascertain whether the fish which systematic naturalists call *squalus maximus*, be the same with that I have now described, it will be necessary to compare this description with that which other writers have given of the fish abovementioned.

Of these, the best we are in possession of is that of Bishop Grunner, published in the Memoirs of the Academy of Norway, which I have not seen, but which, according to the learned Broussonet, is very imperfect*.

Linnæus has made use of this description, and characterizes the fish thus: "*Squalus maximus dentibus caninis, pinna dorsali anteriore majore.*—Habitat in oceano arctico, victitans medusis.—Corpus magnitudine certans cum balænis, simillimum squalo carchariæ, sed absque foraminulo

* Rozier Journal, an. 1785.

“ ante aut post oculos. Pinna ani parva paulo
 “ post regionem pinnae dorsalis posterioris.”

GRUNNER.

But, according to Fabricius*, this huge animal not only feeds on medusæ, but on porpuses, and other small cetaceous fish, which it swallows whole.

According therefore to Linnæus, the characters of the *Squalus maximus* are, that it has canine teeth, the anterior dorsal fin larger than the posterior; and the anal placed somewhat behind the region of the posterior dorsal fin; and neither before nor behind the eyes has the small hole which is found in most of the squali.

When these characteristics are compared with the description given above, we find that they perfectly agree, except that the teeth which, in our fish, are lengthwise, angular and cutting, cannot properly be called canine; and that the small hole above the

* Fauna Groenlandica.

eyes.

eyes is not found, according to Linnæus, or rather Grunier, in the *squalus maximus*.

The reality of these two characteristic marks in the present *squalus* may be confirmed by the example of another fish of the same species, but somewhat smaller, taken in the sea of Marseilles; when, in the year 1781, I went to that city, where fish may be procured in such abundance, to collect specimens of sea-fish for the Public Museum at Pavia, which was then very deficient in such specimens. This fish, from the point of the snout to the beginning of the tail, was five feet and a half in length, and two feet seven inches thick. In both the characteristics above indicated, it was exactly similar to the Messinese *squalus*. The solid longitudinal, and extremely acute angles of the teeth were very visible; as were likewise the two foramina, situated above the eyes, and below the point of the snout; from which latter they are distant three inches and a half, and from the eye one inch. When I procured this fish at

Marfeilles, which was immediately after it was caught, I introduced a probe into the two foramina, and found that it penetrated into the mouth.

These two circumstances; the angular position of the teeth, and, which is still more decisive, the two foramina in the temples, may be considered as distinctive and characteristic marks. The foramina, and the position of the anal fin, have been considered as so important by Broussonet, that in his excellent "Memoir on the different species of Sea-dogs or Sharks" he has founded on them a division of these fish into three orders; the first including the species furnished with the anal fin and foramina in the temples; the second, those that have the anal fin without foramina; and the third, which have foramina without the anal fin. As the *squalus maximus*, according to Grunier, has no foramina, he has placed it in the second order.

We must therefore be obliged to conclude,

clude, either that Grunner was an inaccurate observer, and that he overlooked the foramina and the angular teeth; or that the squalus he has described was a fish different from mine; which I am much rather inclined to believe, as I cannot easily imagine that two things which, when we examine a fish, are peculiarly conspicuous, should either have been not seen by him, or not noticed. I am the more confirmed in this opinion by the consideration, that the squalus of Grunner, Linnaeus, and Broussonet, is an inhabitant of the north seas; whereas that which I have described is a native of the Mediterranean; and frequently in the summer is taken in the Strait of Messina, where it sometimes is found of a monstrous size, and three or four times as large as that which was sent to me.

In the description of this fish I have said, that only the first row of teeth are perpendicular to the plane of the jaw, the other rows being placed horizontally, with their points turned towards the throat, and bu-

ried within the flesh of the jaw; and that none of them have their roots in sockets, but that they are sunk in this flesh. This circumstance, however, is not exclusive, as I find the same has place in the *squalus carcharias*; as we learn from Steno, who, after having remarked that “interiores (ordines dentium) inferiora versus recurvati, gingivarum molli et fungosa carne ita delitecebant clausi, ut non nisi resectis gingivis in conspectum prodirent”, — “the inner (rows of the teeth) are bent downwards, and are so enclosed in the soft and fungous flesh of the gums, that, unless the latter be cut away, they are not visible” — adds — “Cui usui dentes ita incurvatos natura destinavit non perspicuo, cum carnes intra sepulti escæ minuendæ nulla ratione potuerint infervire. Retinendæ prædæ, ne diffugiat, forsitan et diffringendæ majori, quam quæ ventrem subire possit, primi ordinis inferviant; reliqui vero, nisi materiæ necessitate facti, non video cujus gratia sint confecti.” — “For what use the teeth thus bent

" bent were intended by nature I cannot
 " discover; since they are so buried within
 " the flesh, that they cannot serve for grind-
 " ing the food. The teeth in the first row
 " may, perhaps, be designed to prevent the
 " prey from escaping, or to divide it when
 " too large to be received into the stomach;
 " but why the others were formed I do
 " not see, unless we say, that they have
 " been produced by the necessary action of
 " matter."

According to this celebrated anatomist,
 therefore, the numerous teeth which in the
 jaw of the shark are covered with a soft and
 fungous flesh, are of no use to the fish. But
 ichthyologists are not ignorant, that Heris-
 sant was of a different opinion. He found,
 after a very careful examination of several
 jaws of sharks, that the teeth, more or less
 covered with flesh, are teeth of reserve, to
 supply the place of those of the first row,
 should they chance to be lost; in which
 case, these which lie below rise out of the

fungous flesh, and take the place of those that are wanting*.

As there was in the Public Museum a small shark, and some separate jaws of that fish, I could not refrain from examining them, and making some comparative observations between the teeth in them and those of the shark from Messina, as they had nearly the same position.

The shark of the Museum, which had been brought the preceding year from the coast of Africa by the Abbate Rosa, one of the two keepers of that royal establishment, was but a pigmy, when compared with some full-grown ones of the species, its length being only about six feet, and its greatest breadth three feet four inches. The first row of teeth in the upper jaw scarcely projected out of the mouth, with a slight curvature of the points towards the inside

* Mem. de l'Acad. Roy. 1749.

of the jaw. The second row was more bent towards the throat. The other rows lay flat on the jaw, and were the greater part of them sunk within it and covered. The length of the larger teeth is four lines and a half, and their breadth three and a half. The same appearances present themselves in the different rows of teeth in the lower jaw, except that they are smaller, and not serrated like those of the upper jaw. But the dryness and hardness of the jaws in this shark, the mouth of which it was improper to damage, as it belonged to the Museum, prevented me from cutting away the fungous flesh, laying bare the teeth, and examining them in the same manner I had those of the shark of Messina.

This examination, however, I was at liberty to make in the two detached jaws. I therefore, in order to soften them, soaked them for some time in water; and, as they were separated from the fish, I was enabled to handle them as I pleased, and, in consequence, made the following observations :

The

The teeth of the upper jaw are triangular, flat on the outer side, and very slightly convex on the inner, serrated at the edges, in length eight lines, and in breadth, at the base, six lines; I mean those which are near the point of the jaw, for those towards the roots are much smaller. There are four rows of them. The teeth of the first row rise almost perpendicularly to the plane of the jaw, but with their points inclined to the sides. Four of them are wanting; and though their place is not supplied by teeth from the second row, it is observable that four of the latter teeth, immediately correspondent to those that are lost, have raised themselves and pushed forward towards the first row; whence there is every reason to believe that, in time, they would have occupied their place. This is the more probable, as all the other teeth of the second row are extended almost horizontally, with their tops buried in the fungous flesh, as are also those of the third and fourth rows; with this kind of regularity, that the teeth of the second row rest on those of the third, and those

those of the third on the fourth. On divesting, in part, the jaw of the fungous flesh, the teeth of the fourth row are found to be soft, or, at least, not to have the hardness of the others.

Proceeding to examine the teeth of the lower jaw, I found no other difference between them and those of the upper, except that they are proportionally smaller: they resemble them in all other particulars, among which it is not to be omitted that their edges are serrated; and that, except the first row, they are all more or less covered by the flesh of the jaw. It is here to be observed, that two of the teeth of the first row have been broken off at the root, and the thin long cavity in which they were implanted is visible; but, in part, filled up by two teeth of the second row, which have come into the place of those that are wanting.

I was now satisfied that the teeth of the second row, which are bent towards the throat,

throat, are not merely "produced by the necessary action of matter," as Steno has suggested, but designed by Nature to supply the place of those of the first row, when they may chance to be lost, as was first discovered by Herissant; and I flatter myself I am the first who, since he wrote, has confirmed his ingenious and noble observation. And as the teeth of the third and fourth row, as well as those of the second and first, are adherent to the fungous flesh, which is moveable in the anterior parts of the mouth, I have no difficulty in believing that, when any of the teeth of the second row are broken after they have entered into the first, those of the third supply their place, which may be followed by those of the fourth: so that the teeth of those three rows may be considered as supplementary to those of the first.

While employed on the examination of these two jaws, and considering their size, which is, in fact, that of the open mouth of the shark to which they belonged, being thirty inches and a half in circuit, notwithstanding

withstanding the small size of the teeth, of which, as we have seen, the largest are only eight lines long and six broad, I could not but reflect how prodigiously capacious must be the mouth, and consequently how vast the size of the body of those sharks, the teeth of which, improperly denominated *glossopetræ*, are found in a fossil state. I have some of these, one of which is thirty-two lines thick at the base, and thirty-five high. When examined with the utmost care, nothing can more resemble the serrated teeth of the Imperial Museum. If, therefore, the teeth of this fish, which is six feet long and three thick, are only three lines and a half broad, and four and a half high, how much more prodigious must have been the size of the shark which left this gigantic tooth in the earth! How tremendously wide must have been the opening of its mouth and jaws!

It must here be recollected, that I have tacitly supposed the *glossopetra* to have been one of the larger teeth of the shark, or those
of

of the upper jaw towards its point, and which project from the mouth, as in every other part of the jaw they are less. Should the glossopetra have been one of the lesser teeth, the proportion must have been much increased; for had a fossil tooth been found from among those near the middle of the upper jaw, there can be no doubt but its size would have been much greater.

Though sharks of an enormous size have been taken in our times, none have been found to have the extraordinary dimensions which must be inferred from the measure of this fossil tooth. Nor ought this to excite our wonder so much as may be supposed. Teeth and bones of animals of other kinds have been found of a size which clearly proves that individuals have existed beyond comparison larger than those of the same species which at present live and multiply in the known parts of the globe. Such are, for example, elephant's tusks, of a size much larger than that of any natural ones brought us from Asia or Africa. On this
1
subject

subject the Abbate Fortis has written a learned and truly instructive memoir, which well merits perusal, entitled, "*On the Bones of Elephants found in the Mountains of Romagnano in the Veronese*.*" In the year 1791 there was found in the Po, opposite Arena, fifteen miles from Pavia, the head of a deer (*Cervus dama*) which I conceived to merit a place in the rich collection of fossil bones in the Public Museum. It is extremely well preserved, and was found in the natural state of bone, with its teeth, and wanting a horn. Its value consists in its size; it being more than twice and a half larger than the heads of animals of the same size; as I proved by comparing it with the heads of deer which had reached their full growth in a state of liberty. The horn it bears is of proportionate size. The year after I procured for the same cabinet, a prodigious thigh-bone of an elephant, found in the same place; where, a short time before, a skull had likewise been found, which had every appear-

* Dell' Ossa d'Elenfanti de' Monti Romagnano nel Veronese.

ance of being that of an ox, but was of an enormous size.

With respect to sharks, it may, perhaps, be true, that they would still grow to the vast size which we have shewn they attained to in former ages, were they not prematurely killed by fishermen and mariners, on account of the utility derived from their flesh, their fat, and their skin. We likewise know that the insatiable eagerness of these voracious fish for the bait prepared for them, renders them easily taken. Thus, when whales were first fished for in the northern seas, they were frequently found of an astonishing size; but since the fishery has been constantly repeated every year, they are never met with of such extraordinary dimensions.

Linnæus tells us that the *squalus carcharias* has six rows of teeth, and that these teeth are serrated. At first view this seems not to agree to the animal I observed, since, as we have shewn, that has four rows, and not six; but as we have seen that the teeth of
the

the fourth row are soft, it is very possible that their germs may have begun to develop after those of the anterior rows, and hence we may presume that other rows may afterwards appear. In like manner, though in the smaller sharks the teeth of the lower jaw are not serrated, they are in those of a larger size, of which I examined the jaws. We may therefore conclude that, in sharks, teeth are in time produced which they had not when young, and that these teeth are liable to changes, such as is that of becoming serrated. Thus, the teeth included in sockets in the long bony snout of the saw-fish (*squalus pristis*) do not appear till the animal has arrived at a certain age.

The most remarkable circumstance relative to the shark, and which seems constant in all its different ages, is the privilege it possesses of re-acquiring, in a certain manner, the teeth it has lost. But is this privilege confined to the shark alone, or enjoyed by other fish? It certainly appears to extend to such as have, first, several rows of teeth; secondly, those

teeth not infixed in the bone of the jaw, but in the soft flesh of it ; and thirdly, the teeth of the hinder rows turned towards the throat, and covered with the flesh of the jaw. These three circumstances concur in the *squalus carcharias* (the white shark) ; and, as they likewise concur in the squalus of Messina, it should seem that the latter must likewise enjoy the same privilege. But this is not verified by observation. Several teeth, as I have already said, are wanting in the first row ; but the corresponding, in the second, are not in the least raised, but are still bent backwards, precisely like the rest of the same row.

Before I conclude these remarks, which I have considered as of sufficient importance to prove interesting to my readers, I shall give a brief description of the very singular dentature of two jaws similar to that of the squalus of Messina, which were brought with a number of exotic fishes from Holland, and appear to have belonged to a very large squalus, but of a species hitherto unknown ;

fin.

at

at least I do not find teeth of a similar structure described by any writer.

The opening of the jaws is full three feet and a half in circuit, and consequently large enough to receive a man of middling size lengthwise. The upper jaw, which is rounded in front, has five rows of teeth. The first and second row represent so many combs as they contain teeth; only with the difference that those nearest the base, and that in the middle of the jaw, are smaller than the others. Every one of these combs is dentated on each side with ten teeth, extremely sharp at the point, bent towards the base of the jaw, and successively larger in proportion as they approach the middle. The upper side projects from the mouth, and the lower looks downwards: the two sides are not parallel, but, with the body of the comb, form a plane narrowing towards the base of the jaw, and enlarging on the contrary side. The combs (or the teeth of the first and second row) are contiguous, having between them only an obtuse-angled

space toward the top, and by their middle, lengthwise, are solidly attached to the semi-cartilaginous skin of the jaw.

Such are the principal peculiarities I remarked in the two first rows of teeth. But under the second row there is a third; under that a fourth, and under that a fifth. Each of these three rows of teeth forms, in like manner, a dentated comb, with ten teeth, similar to those of the two upper rows, except that these combs are only dentated on one side, while the other is firmly fixed in the flesh of the jaw. Except the first row, therefore, the others are deeply buried under a stratum of fungous flesh, which must be taken away to render them visible.

I omit to mention a multitude of small teeth, long, smooth, and obtuse, situated at the roots of the jaw, and under the pectinated teeth.

These teeth, then, are disposed in five rows, which number five, being multiplied by thirteen,

teen, for the whole jaw, produces sixty-five: the number of pectinated teeth.

Of these one of the largest in the first row is wanting, being entirely detached from the jaw. This loss could not have been recent, when the fish was taken, as the fungous flesh had formed a scar over the place it had occupied, producing an angular elevation of some thickness. If, therefore, the second row of these teeth, and the same may be said of the other lower rows, had been designed by nature to supply the deficiencies that might happen in the first, it is evident that the tooth below would have occupied the place of the tooth wanting, or at least would have raised itself up and approached nearer to it. The fact however is, that this tooth, which we might have supposed to be formed as a substitute, is by no means such, but still continues in the same position with the others, and covered in the same manner with the fungous flesh.

In Plate XI. I have given the figure of

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the

the upper jaw, with the pectinated teeth. The reference A. indicates the tooth that is wanting.

The lower jaw, which is shorter than the upper, and sharp in the middle, is provided with a dentature entirely different. Every tooth is full two-thirds smaller than those formed like combs, is bicuspidated, tricuspidated, or quadricuspidated, there being no constant rule, and the points are turned to the sides of the jaw. Some of these teeth project, as they appear in Plate XI. in which the lower jaw is represented as joined to the upper. They are in three rows, and every row contains, in the circuit of the jaw, fourteen teeth. Those of the second and third rows, as usual, lie flat, and are covered with the fungous flesh. Those of the first row are in a position almost perpendicular. They are all deeply rooted in the flesh. In this jaw, likewise, the first row is not complete, several teeth being wanting. Their place, however, has not been supplied by those of the second row; nor is there any
appear-

appearance, indicative of such a substitution, as they all lie flat in the mouth like the others of the same row.

From what has been observed of this fish, of the species of which I am ignorant, and of the other taken near Messina, which from some of its characteristics has been confounded with the *squalus maximus*; it is evident, that though their teeth are found in precisely the same circumstances with those of the teeth of the *squalus carcharias*, as observed both by Herissant and myself, yet they have not received from nature the privilege of repairing the loss of their teeth by the substitution of those that remain.

But if these teeth thus turned towards the throat, and enveloped in flesh, are not placed there in reserve, and intended to supply the place of those that may be lost, naturally or by violence, what can be their use? It is certain that, if during the whole life of the animal they remain in the mouth in the same position, they can be of no service to

them with respect to their prey, as they are unfit either to seize it or grind it. In like manner they cannot be offensive weapons against their enemies, in the combats in which it is known these fish are continually engaged. Shall we then adopt the improper suggestion of Steno, and ascribe their formation merely to "the necessary action of matter?"

I am far from wishing to give a hasty judgement relative to the ends nature has had in view. Of many of them we are profoundly ignorant, and many, it is probable, we shall never discover. Yet there are others so apparent that we cannot be mistaken. There cannot be a doubt, for example, that the teeth in most animals are an offensive and defensive weapon, besides serving for the trituration and mastication of their food; and that in others their office is to seize and hold fast the prey till it shall be swallowed and pass into the stomach. Sharks, like an infinite number of other fish, do not masticate; but use their

teeth to seize their prey, employing those of the first row, which when they are lost have their place supplied by those of the lower rows, such being their destination. In the two species which I have described there is a difference; the teeth of the first row, which project from the mouth, being alone adapted to seize and prevent the escape of the prey. These, however, when they fall out naturally, or are broken off by violence, are not restored, since the teeth which would supply their places in the common shark have not the same property in these species of fish. The teeth, therefore, of the second and following rows are of no service to these animals, with respect to the prey they may take or attempt to take. But shall we therefore conclude that they are entirely useless? I will not be so presumptuous as to entertain such a thought. The lower rows of the teeth of the common shark were once supposed useless, until by careful and accurate examinations of different jaws their real and truly important use was discovered. Of the species now in question

question I have only seen three jaws: perhaps, had I an opportunity to examine more, especially such as had belonged to fish of different ages, I might be able to elucidate this, at present, difficult question.

In the mean time, what has been now observed may teach us how cautious we ought to be in judging from analogy. What greater analogy, not to say identity, can be conceived than that between the circumstances attending the lower rows of teeth in the common shark, and those of the same rows in the two species we have last described? How natural, therefore, was the conclusion, that if these rows were intended to supply the place of such as might be lost or broken, in the former animal, they had the same destination in the latter? Yet has observation shewn that this inference is false. Whence it appears, that by trusting to analogy we may be sometimes led into error; by attributing, as in the present case, to one species of a genus what is only true of another.

In these experimental enquiries I have considered the *squali* as fishes, properly so termed, though Linnæus has taken them from that class, and placed them in that of amphibia, in which he has also the rays, lophii or sea-devils, lampreys, &c. because, according to him, these genera have perfect lungs. But it has been demonstrated by more accurate observations made by M. Vicq-d-Azyr, that they have not these viscera; of which I have myself been convinced with respect to several species of rays, and other fish that had been improperly supposed to belong to the class of amphibia.

In those experimental auditions I have considered the *Spizella* as three, properly so termed, though *Linnaeus* has taken them from that class, and placed them in that of *Amphibia*, in which he has also the *Tringa*, *loquax* or *sea-devil*, *lumpreys*, &c. because, according to him, these genera have perfect lungs. But it has been demonstrated by more accurate observations made by M. *W. d. A. d. A.* that they have not these lungs; of which I have myself been convinced with respect to several species of *Tringa*, and other birds that had been improperly supposed to belong to the class of *Amphibia*.

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FIG. I.



FIG. II.



FIG. III.



FIG. IV.

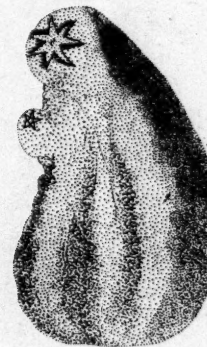


FIG. V.

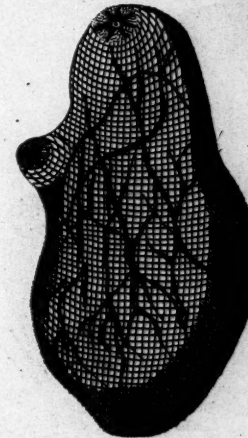


FIG. VI.

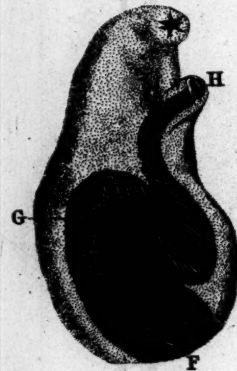


FIG. VII.

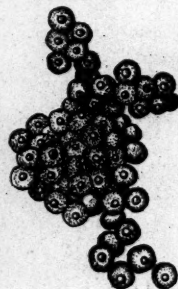


FIG. VIII.

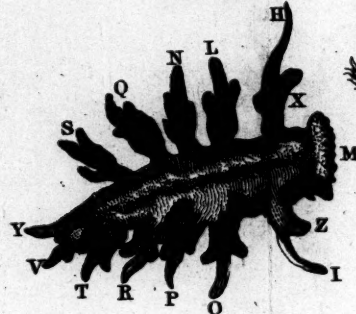


FIG. IX.



FIG. X.

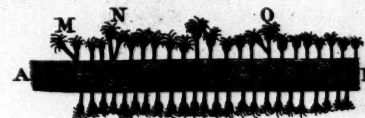


FIG. XI.

